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COLORS OF VEGETATION.*

BY PROF. D. S. JORDAN.

The coloration of plants is due to the presence in the cells of minute globules, which are usually green in the herbaceous parts, the leaves, sepals, etc., and of various hues in the flowers and fruits.

The normal color of foliage is green, but it may be of almost every conceivable shade and degree of intensity. It may be of a yellowish-green as in the parsnip, or of a blue-green as in the sweet pea. It may be pale and shining as in the orchis, or dark and shining as in the laurel. It may be intense and vivid as in the young leaves of the horse-chestnut, or of a neutral Portage sandstone color as in the Cassandra or leather leaf.

The causes of these differences are partly chemical and partly physical: the chemical causes producing the different shades of color, the physical the differences in brightness and intensity.

First, as to the chemical differences. The French chemist Frémy finds that chlorophyl or leaf green is composed of two distinct substances: the one of a bright blue color which he calls *phyllocyanin;* the one of a yellow color known as *phylloxanthin*. The unequal proportions of these two ingredients which are simply mixed in the leaf cells would account for the absolute differences in color. Thus in the bluish-green leaves of the pea

*Read before the Cornell University Natural History Society.

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family the blue substance should be found to predominate, and in the yellowish-green leaves of the hickories the yellow substance should be in the ascendant. Indeed it has been found that, in the outer leaves of the cabbage, the phyllocyanin or blue substance exists in much greater proportion than in the inner leaves which have been deprived of sunlight.

Now as to the physical causes producing differences of intensity. In the dark shining leaves such as those of the laurel, prince's pine, partridge berry, etc., the depth of color is due to the closeness with which the cells are packed together. Each cell contains a globule of chlorophyl, and it is evident that, other things being equal, the smaller the cells and the more compact their arrangement, the darker will be the color of the leaf.

And as to the differences in vividness of color. In the young leaves of the horse-chestnut, the cuticle is very thin and the cellular substance of the leaf is very transparent; hence the green of the globules of chlorophyl shows brightly through. On the contrary, in the Cassandra or leather leaf, the cellular tissue is of a thick husk-like texture and the leaves are of necessity dull colored. The blue coloring substance in leaves is much less stable than the yellow. It rapidly decomposes or is transformed in the absence of sunlight. You have all noticed what a yellow hue the foliage of trees wears in wet and cloudy springs, and even in summer, a week or two of sunless weather will often make a perceptible difference in the color of the woods. Always the lower and inmost leaves of a tree are paler than the rest and of a yellowish hue, like the complexion of boys "brought up in the house." Cold weather bleaches chlorophyl and vegetable coloring matters generally. The further north we go the more liable do we find plants to albinism or loss of color. Flowers of Arctic or mountainous regions are always paler and more delicate in hue than those of warm countries and they are far more subject to white varieties. Linnæus says that "there is not a single blue or red flower in Lapland that has not its white varieties." The yellow coloring matter is much less easily affected by absence of light and other causes and yellow flowers rarely exhibit any striking variations in hue. Many plants are entirely destitute of chlorophyl. These are parasites, and as they depend for their nutrition on the sap already elaborated by the supporting plant they have no need of chlorophyl. The cells may be filled with orange-purple

or tawny coloring substances or they may be empty, leaving a white plant, like the Monotropa and mushroom. Lichens and fungi growing on living or decaying organisms have also no need of chlorophyl; hence in the economy of nature they are unprovided with it. They often exhibit bright tints due to the presence of various coloring matters whose character is not well understood. Recent experimenters have succeeded in isolating some forty different coloring substances in a species of mushroom. Some fungi are luminous like the glow-worm. I do not know the theory of this. That peculiar luminosity of rotten wood, often supposed to be "phosphorescence" and known by woodsmen as "fox fire," is due to the presence of a species of fungus.

Much has been written about autumn coloration, but the subject has been treated from an æsthetic rather than from a scientific standpoint. We are more interested in "the rosy cheek than we are to know what particular diet the maiden fed on." However, in a general way, we say that the bright colors of leaves in the fall are caused by the oxidation of the chlorophyl. This is really a process of ripening. A brilliant autumn leaf is not dead but mature. "Flowers are but colored leaves, fruits are but ripe ones. The edible part of most fruits is the parenchyma or fleshy tissue of the leaf of which they are composed." The ripening of a maple leaf and a red astrachan apple is precisely the same process. In both cases it is an absorption of oxygen and a change of the blue substance of the chlorophyl to red. The yellow substance is not easily acted upon, hence the prevailing color of autumn foliage is scarlet, which is a mixture of yellow and red.

M. Châtin has a different theory as to the production of scarlet leaves. He claims that the entire mass of chlorophyl is oxidized first to yellow and then to red, and that red leaves contain yellow chlorophyl in the inner cells which has not yet been oxidized. He thinks that yellow leaves in autumn are those in which the process has been arrested at the yellow stage before they arrive at redness. But the leaves of the oaks become crimson without passing through any intermediate stages of yellow or scarlet. This theory also appears improbable in the case of the hickory, aspen, etc., whose bright yellow autumn foliage shows no tinge of red. Besides such a change as he imagines would be inconsistent with the theory of the compound nature of chlorophyl.

It seems to be pretty well established by the experiments of

M. Cloez and others on the different varieties of hyacinth and bachelor's button (Centaurea cyanus), that oxygenation or acidification changes vegetable blues to red, and that the two colors are chemically identical and chemically distinct from the yellow. In ordinary leaves, we find the blue and yellow substances nearly in equilibrium, but in the colored parts of the flower, one or the other predominates. Thus flowers are naturally divided by their colors into two great classes, according to whether the cyanic or xanthic principle is in the ascendant.

Desvaux, one of the most painstaking of observers, has studied for ten years the gradations of color in the twelve hundred varieties which have been produced of the kidney bean. He divides the colors of flowers into two series.

1st. The cyanic series, those having blue for their type and capable of varying to red or white, but never to yellow.

2d. The xanthic series, those having yellow for their type and capable of varying to orange or white, never to blue. Both series commence in green, which is blue and yellow, and end in white which is the absence of all color.

Thus the tulip was originally yellow. All of its varieties belong to the xanthic series. So with the dahlia and zinnia. There never was a blue tulip, primrose or dahlia. The geraniums, phloxes, verbenas, etc., vary throughout the cyanic series, and a yellow geranium or phlox is unknown.

Different species of the same genus sometimes belong to different series, as is the case with the roses and violets. Rarely different parts of the same flower belong to different series as in the convolvuli and forget-me-nots. Though the rules of color are liable to many exceptions, yet it seems to me that Linnæus' great maxim "Nimium ne crede colori," "Put not your trust in colors," is too absolute. For example, the hue of a single petal of Solanaceæ stamps at once the order.

"The science of Vegetable Chromatology," observes M. Guérin, "is yet in its infancy; and it is impossible to establish any rules to which there are not many exceptions."

All theories yet advanced, however ingenious they may be, are liable to objections of such great weight that none can be admitted as absolutely true. For example, let us take the theory of Macquart, that "color results from the decomposition of carbonic acid and the disengagement of oxygen, and that its intensity is propor-

tional to the amount of luminous fluid—light, which is present." This decomposition can take place only in the presence of sunlight and chlorophyl, but there are many parts of plants in which chlorophyl is entirely wanting and which develop in the absence of light, yet which nevertheless are brightly colored. Roots and tubers are often of brilliant hues, as in the carrot and gold-thread. So also the inner wood of a tree, as in the magnolia and rosewood. These colors are formed in the presence neither of sunlight nor chlorophyl, so there must exist other causes of coloration than that allowed in the theory of Macquart.

Again, although submarine vegetation is usually of a dull green or brown, we find many seaweeds which are brilliantly tinted, although they receive but a very feeble light. Although chemical analysis throws some light on the laws of vegetable chromatology, yet the color of the flowers cannot in general be taken as any index of the medical properties of plants, for we may find the same colors at once in the most poisonous herbs, as fox glove and belladonna, and in the most innocent, as the primroses and violets.

The flowers of many plants are subject to changes in color. The closed gentian, for example, changes from a deep indigo-blue to a reddish-purple. The white Trillium becomes of a delicate rose color just before it withers. The ray flowers of Xeranthemum are straw color when they first expand becoming, at last, of a bright crimson. A more striking example is the *Gladiolus versicolor* which is brown when it opens in the morning, changes to a clear blue in the noonday sunshine and returns to brown again at night to go through the same variations the next day.

Black as a color exists in vegetation only in the roots, seeds and a few fruits. It does not occur in the flowers. All the approaches to it, as in the case of the dark spot on the corolla of the coffee bean, are simply an intense violet. There are no flowers of a pure white. The famous flower painter Redouté, observed long ago that in flowers which appeared white, there is always a faint tinge of rose color, yellow or blue. When a white petal is viewed by transmitted light we see various shades produced by some coloring matter present in the cells in a state of extreme dilution. White frequently with a tinge of pink is the most common color in spring flowers and in flowers of Arctic regions. Red is the hue of summer flowers and of acid fruits; bright red is rarely

seen in early spring flowers and in the autumn it also disappears. But in June and July, the flowering time of the roses, laurels and azaleas, it is one of the most abundant colors. Yellow is more properly an autumnal color, and it often characterizes large groups, as the golden rods, sunflowers and buttercups. Blue is a summer color, but it runs throughout the year from the hepaticas of the hue of the March sky above them, to the fringed gentians and asters of the November woods.

Numerically, yellow flowers are far the most abundant: next comes white, then red and blue. Red is very often the hue of the stems of plants especially in late summer and autumn. This is common among the grasses, some of which brighten into a purple mist as intense in color when seen at a little distance, as the most brilliant patches of laurel or meadow beauty.

"In most plants," says Thoreau, "the corolla or calyx is the part which attains the highest color and is the most attractive; in many it is the seed vessel or fruit, in others still it is the very culm itself which is the blooming part."

In conclusion we come to the question, what is the use of the colors of vegetation? In a strictly utilitarian point of view they seem unimportant. There are some plants, chiefly orchids, which require the aid of insects to secure fertilization and which attract them by their bright colors, but these plants are very few and most flowers could accomplish their destined purpose just as well were they clad in the drab of the veriest Quaker.

The flowering time is the nuptial season, the honeymoon of the plant, and it is the nature of flower and beast, of bird and man to "spruce up," to put on his brightest colors at pairing time.

The science of Vegetable Chromatology is one in which much is seen and little is known. We can all see with our own eyes that plants are variously colored: that even Solomon in all his glory was not arrayed like one of our meadow lilies; but when we get beyond our eyes and ask why this is so, we find ourselves at a loss; we cannot answer. We only know that the Lord doeth as pleaseth Him with the flowers in his garden.

ON THE LIMITS OF THE CLASS OF FISHES.

BY THEODORE GILL, M.D., PH.D.

In the classification of the animal kingdom the vague ideas prevalent among the vulgar and originating in prejudices based on habitat or external appearance have been more or less reflected, and special forms associated with earth, air and water. Thus were the inhabitants of the "element" associated together on the one hand, and separated from those of other "elements" in the other by the ancient cosmologists and poets.* This was the first generalization or attempt to combine the groups which from all time have been recognized as "beasts" or "animals," "birds," "fishes," and others in still more comprehensive groups. But, in time, and as investigation was directed to the structure of animals, it was found that the preconceived ideas respecting the relations of the various forms to the media which they inhabited, were by no means the correct expressions of the relations of such forms in structural features. The recognition of this fact resulted in the admission of several classes (anticipating the definite ideas which are now associated with such groups) and the virtual separation of the vertebrates from the invertebrates. But the ancient

* In the beginning God created the *heaven* and the *earth*. And the earth was without form and void.

And God made the firmament, and divided the *waters* that were *under* the firmament, from the *waters* that were *above* the firmament: and it was so. And God said: Let the waters under the heaven be gathered together unto one place, and let the *dry land* appear: and it was so.

And God said: Let the *waters* bring forth abundantly the *moving creature* that hath life, and *fowl* that may fly above the earth, in the *open firmament* of heaven.

And God said: Let the *earth* bring forth the *living creature* after his kind, cattle and creeping thing, and beast of the earth after his kind: and it was so.— *Genesis, Ch. I, verses* 1, 2, 7, 9, 20, 24.

The same idea is expressed by several of the ancient poets and especially by Ovid in the following lines:—

> Ante mare et tellus, et, quod tegit omnia, cœlum,
> Unus erat toto naturæ vultus in orbe,
> Quem dixere Chaos; rudis indigestaque moles;
>
> . . . . . .
>
> Hanc Deus et melior litem natura diremit:
> Nam *cœlo terras*, et terris abscidit *undas*;
>
> . . . . . .
>
> Ne regio foret ulla suis animantibus orba:
> *Astra* tenent *cœleste* solum, formæque deorum;
> Cesserunt nitidis habitandæ *piscibus undæ*;
> *Terra feras* cepit; *volucres* agitabilis *aër*.
>
> — *Ovid, Met. I*, l. 5–7, 21–22, 72–75.

idea of a certain relation between form and habitat still prevailed to a greater or less extent, and the vertebrates, in the earliest days of systematic zoology, were instinctively divided into quadrupeds, or animals especially fitted for progression on land; birds, especially adapted for flight and fishes, destined for life in the waters; while those animals not referable to either category, such as reptiles, bats, etc., were slurred over or forced into combination with the others on account of some points of real or supposed agreement. Soon, however, the distinction of the cold-blooded quadrupeds from the warm-blooded ones (mammals) and the affinity of the former and the serpents were recognized, and the class of "reptiles" constituted. It was long before it was fully and generally acknowledged that the latter was a heterogeneous assemblage of forms having very diverse relations, part of them being closely related to birds, and the others almost undistinguishable from fishes. Such recognition has now become practically universal, but, at this point, the progress of zoological taxonomy as exhibited in the appréciation of the subordination of types has been to a great extent arrested, and naturalists have mostly been content to recognize the five classes, Mammals, Birds, Reptiles, Batrachians, and Fishes. Several naturalists, however, have dissented from this view, and indeed the class of fishes has not been so universally recognized with the limits the mind is still most apt to connect with it as is usually supposed.

The Class and its modifications.—The cetaceans and fishes were regarded as a group coördinate with the warm-blooded quadrupeds (mammals) and birds, either avowedly or by implication, till Brisson, in 1760, finally withdrew the former from the class, and placed them in more immediate relation with the warm-blooded quadrupeds, regarding them, however, as constituting a peculiar class: the class of fishes, thus relieved, was for the first time presented with the limits since generally recognized.

It is true that, as a matter of fact, the agreement of the cetaceans with the mammals in their respiratory apparatus and warm blood had been long previously recognized, even by Aristotle and indeed by every observer capable of comparison of facts, but in spite of such recognition, the apparent agreement in form and adaptability for progression in the waters exercised such a preponderant influence over the mind, that the hints thus offered were not accepted in their fulness till 1758 by Linné.

Linné first, in the tenth edition of his "Systema Naturæ" (1758), eliminated the cetaceans from the class of fishes and combined them with the viviparous quadrupeds in a single class, for which he proposed the now universally accepted name Mammalia. At the same time that he eliminated the cetaceans, however, he violently divorced from the class of fishes and referred to the amphibia, under the name Amphibia nantes, first (in 1758), all the Chondropterygii of Artedi (except the sturgeons) as well as the genus Lophius; and, subsequently (1766), he removed still others from the class, completing the removal of the Chondropterygii by the exclusion of the sturgeons, and discharging at the same time the genera Cyclopterus, Balistes, Ostracion, Tetrodon, Diodon, Centriscus, Syngnathus and Pegasus, most of which formed the Branchiostegi of Artedi. He seems to have been led to this measure by the belief that they were provided with lungs instead of gills, apparently having been misled by an erroneous observation of Dr. Garden, of Charleston, on Tetrodon.

Gmelin, in his edition of the "Systema Naturæ" (1788), restored to the class the forms thus divorced from the fishes.

The genus Myxine was referred to the class Vermes by Linné and his followers, and therefore doubtless was overlooked by Bloch, who redescribed it as a fish under the name Gastrobranchus.

The constituents of the class having been at length, for the time, agreed upon, the question of its subdivision or union with others was next agitated.

Pallas combined the fishes with the Amphibia of Linné in a class, coördinate with mammals and birds, which he named Monocardia. Long afterwards, Prof. Owen adopted the same view, but gave the new name Hæmatocrya.

On the other hand, the elder Geoffroy St.-Hilaire, and following him, Latreille,* separated the combined Elasmobranchiates and Marsipobranchiates as a class (equivalent to the order Spiraculata of Pallas), and named it Ichthyoderes or Ichthyodera. This view, however, fell still-born.

In 1856, Prince Charles Bonaparte† recalled that Isidore Geof-

* LATREILLE (Pierre André)—Familles Naturelles du Règne Animal, exposées succinctement et dans un ordre analytique avec l'indication de leurs genres. Paris, J. B. Baillière, Libraire de Bandouin Frères. 1825. [8vo, 570 pp.]—Troisième Classe, Ichthyodères, Ichthyodera (G. St. H.), p. 107; Quatrième Classe, Poissons, Pisces, p. 112.

† Bonaparte (Prince Charles Lucien) Additions et corrections aux Tableaux paralléliques de la deuxième sous-classe des Oiseaux, Præcoces ou Autophages; . . .

froy St.-Hilaire* had, in 1852, separated from the class of fishes as the type of a new class (Myelozoa) the genus Branchiostoma or Amphioxus (a species which was originally described by Pallas as a member of the molluscan genus Limax), rediscovered and first referred to the class of fishes by Costa in 1834. Bonaparte, at the same time, proposed to withdraw from the invertebrates the genus Sagitta (Quoy and Gaimard) and elevate it to the rank of a class (Aphanozoa) of the vertebrates.†

In the elevation of Sagitta to the rank of a class Bonaparte has anticipated Professors Carus and Huxley (who also elevated the same form to class rank, retaining the name Chætognatha, originally conferred upon it as the type of an *order* by Leuckart). But his views respecting its pertinence to the branch of vertebrates are untenable, for there can now be no doubt that it is at least most nearly related to the class of annelides.

In 1857, the question of the primary classification of fishes was again reviewed by Prof. Agassiz. That eminent zoologist "was satisfied that the differences which exist between the Selachians (the skates, sharks, and Chimæræ) are of the same kind as those which distinguish the amphibians from the reptiles proper and justify, therefore, their separation, as a class, from the fishes proper. I consider also (he adds) the Cyclostomes as a distinct class for similar reasons; but I am still doubtful whether the Ganoids should be separated also from the ordinary fishes." He finally however admitted four classes, viz:—

"1st class; Myzontes with two orders, Myxinoids and Cyclostomes.

(Suite et fin.) <Comptes rendus hebdomadaires des séances de l'Académie des Sciences, (1er Dec. 1856) XLIII. 1017-1027.

* I have been unable to find any memoir or paragraph in any work by Geoffroy St.-Hilaire embodying the view referred to, and suspect it may have been a verbal communication, and never actually published.

†Que le Sagitta, Quoy et Gaimard, cet animal singulier si commun dans les mers du Nord, découvert par nos intrépides voyageurs, et ballotté par les savants entre les Mollusques, les Vers et jusqu'aux Acalèphes! possède dans la première période de sa vie une grosse corde dorsale qui en fait un Vertébré subissant une métamorphose rétrograde dans le sens de Rathke. C'est à M. Meissner, jeune professeur à Bâle, qu'on doit cette belle découverte. Cet animal, qui dans l'état actuel de la science ne pourrait être regardé que comme un Poisson, pour ainsi dire, dégradé, mériterait de former une classe à part, bien plus encore que l'Amphyoxus ou Branchiostoma, dont notre savant Président a fait le type de sa classe des *Myéliaires* (Myelozoa), depuis 1852.

En effet, la corde dorsale (qui forme le distinctif essentiel des Vertébrés) s'oblitérant et disparaissant complétement dans l'adulte, constitue un caractère tellement important, qu'il ne peut désigner un groupe d'un rang moins élevé que celui de classe; il pourrait être convenable de donner à cette classe le nom *d'Aphaniaires* ou Aphanozoa. *Op. cit.* p. 1022.

2d class; Fishes proper with two orders, Ctenoids and Cycloids.

3d class; Ganoids with three orders, Cœlacanths, Acipenseroids, and Sauroids; and, doubtful, the Siluroids, Plectognaths and Lophobranches.

4th class; Selachians with their orders, Chimæræ, Galeodes, and Batides."*

The Leptocardians and Dipnoans were not referred to in this essay and consequently it is doubtful what the author considered to be their relations.

In 1866, Prof. Häckel also divided the fishes into four classes, but on entirely different grounds and with extremely different limits from those proposed by Prof. Agassiz; the classes recognized by Häckel being represented severally by (1)Branchiostoma (Leptocardia), (2) the Myxinoids and Petromyzontes (Cyclostoma) and (3) all other fishes (Pisces) except Protoptera, which (4) constitutes a fourth class (Dipneusta). Häckel, moreover, does not consider the fishes as a group coördinate with any combination of other vertebrate classes; contrasting the Leptocardia in a group (Subphylum Leptocardia or Acrania) opposed to all the rest of the vertebrates (Subphylum Pachycardia or Craniota); and under the latter opposing the (1) Cyclostoma in a "cladus" or superclass Hauptklasse Monorrhina), coördinate with (2) another (Anamnia) containing the fishes, "Dipneusta," "Halisauria" (extinct swimming reptiles), and Batrachians, and (3) a third (Amniota) embracing reptiles, birds and mammals.†

In 1868, Prof. Cope,‡ in a suggestive article on the doctrine of evolution, considered the Leptocardii, Dermopteri, Elasmobranchii, Teleostei (including Ganoidei as a subclass) and Dipnoi to be groups coördinate with the Batrachia, Reptilia, Aves and Mammalia and therefore classes:§ in a subsequent memoir, he reiterates more distinctly the same opinion, remarking that "The *classes* Aves, Reptilia, and Batrachia are those over which the present review extends. The *classes* of vertebrata not included are: the

* Agassiz (Louis). Contributions to the Natural History of the United States of America, I. 1857, p. 187 (=Essay on classification, chap. iii, section i).

† Häckel (Ernst). Generelle Morphologie der Organismen, b. 2 (Allgemeine Entwickelung-geschichte der Organismen), 1866, pp. cxviii-cxxix; also *ib.* Natürliche Schöpfungs geschichte (18?8), 2e. auil. 1870, pp. 512-513, etc.

‡ Cope (Edward Drinker). On the Origin of Genera . . . . < Proceedings of the Academy of Natural Sciences of Philadelphia, 1868, p. 25?-265.

§ The groups in question are arranged in the same vertical line in five tables exhibiting anatomical details in which the subordination of groups appears to have been carefully considered and attempted to be represented.

Dipnoi, Pisces, Elasmobranchii, Dermopteri, Leptocardii and the Mammalia.*

Subsequently, in a most important special memoir on the classification of fishes, Prof. Cope † (if I understand his views) recognized (as classes) six groups of Vertebrata; Mammalia, Sauropsida (birds and reptiles), Batrachia, Pisces, Dermopteri, and Leptocardii. After enumerating these groups, he adds: "These six *classes* of Vertebrata appear to be well established."

Three classes among Fishes.—After a careful survey of the field, the author had independently, several years ago, arrived at the same conclusion as Prof. Cope respecting the old class of fishes, but had neglected to announce them except in conversation with others engaged in like pursuit, and in lectures. He had, however, somewhat inclined to the recognition of the Elasmobranchiates as a class, but considers such at present inadvisable and perhaps uncalled for by the evidence; like Prof. Cope, he cannot agree with Prof. Häckel in the separation of the Dipnoans from the class Pisces, the relations of that form with Polypterus and other universally recognized Ganoids being more intimate than those between such Ganoids and the typical fishes. The number of classes recognized as confounded under the common designation of fishes will then be three, viz:—

I. PISCES.

SYNONYMES, AS CLASSES.

<Pisces. *Artedi*, 1738, Linné, 1735-1754 (incl. Cete).
>Pisces. *Linné*, 1756, etc. (excl. *Chondropterygii*, etc.)
>Poissons (Pisces), *Geoff. St. Hilaire, Latreille*, 1825.
>Ichthyoderes (Ichthyodera), *Geoff. St. Hilaire, Latreille*, 1825.
>Fishes proper, *Agass.*, 1857.
>Ganoids, *Agass.*, 1857.
>Selachians, *Agass.*, 1857.
>Pisces, *Häckel*, 1866.
>Dipneusta, *Häckel*, 1866.
>Dipnoi, *Cope*, 1868.
>Teleostei, *Cope*, 1868.
>Elasmobranchii, *Cope*, 1868.
=Pisces, *Cope*, 1872.
Fishes part., *auct. plur.*

* COPE (E. D.) Synopsis of the extinct Batrachia and Reptilia of North America, 1869, p. 3; Trans. Am. Phil. Soc., v, 14, p. 3.

† Cope (Edward Drinker). Observations on the Systematic Relations of the Fishes. (Contributions to the Ichthyology of the Lesser Antilles, §I.) <Transactions of the American Philosophical Society (Philadelphia), 2d series, v. 14, pp. 447, 1872.

The same memoir with the same title is printed in the American Naturalist for September, 1871 (vol. 5, pp. 579-593, and in the Proceedings of the American Association for the Advancement of Science, 1871, (1872) pp. 317-343, but without the paragraph cited.

II. MARSIPOBRANCHIATES.

SYNONYMES, AS CLASSES.

<Ichthyoderes (Ichthyodera). *Geoff. St. Hilaire. Latreille*, 1825.
<Myzontes, *Agass.*, 1857 (including *Amphioxus*?).
=Cyclostoma. *Häckel*, 1866.
=Dermopteri. *Cope*. 1868. 1872.

SYNONYMES, AS SUBCLASS.

= Marsipobranchii. Bon., 1840 (incl. Leptocardii).
= " Müller, 1841 *et auct. plur.*
< " Bon., 1846.
<Dermopteri. Gill. 1861. Owen. 1866.

III. LEPTOCARDIANS.

SYNONYMES, AS CLASS.

=Myelozoa. *Is. Geoff. St. Hil.*, Bon., 1856.
<Myzontes, *Agass.*, 1857.
=Leptocardia. *Häckel*, 1866.
=Leptocardii. *Cope*, 1868. 1872.

SYNONYMES, AS SUBCLASS.

=Leptocardii. Müller. 1841. *et auct. plur.*
<Dermopteri. Gill. 1861. Owen, 1866.

These three classes appear to be better entitled to such distinction than any of the higher classes of vertebrates, both on account of the greater taxonomic value of their distinctive characters, and their isolation from the next allied forms; and in both these respects, they are, for example, far more worthy of recognition than the classes of birds and reptiles as distinguished from each other, or the Pisces on the one hand and the Batrachians on the other. The difficulty, indeed, in the case of the inferior classes consists not in the inability to distinguish them from each other, but in the task of tracing the homologies between them, and there is no evident reason why this state of facts should not be to some extent reflected in the classification. The chief objection thereto of which the author is aware is a current and vague idea that what are called lower forms are more elastic and exhibit a wider range of variation than superior ones, and by *assuming* that all low forms of any branch, however much they may differ in structure, are constituents of a natural group to be compared with several more restricted higher ones; such views may be enforced, but are liable to be considered, and only worthy of being treated, as *petitiones principii*.

Certainly, the differences between Branchiostoma (*Amphioxus*) and its nearest of kin are as evident and striking as those between

any contiguous classes in the entire animal kingdom ;* that, furthermore, they are significant of the highest class taxonomic value is indicated by their fundamental nature, and the coördination of all parts of the organization.

There is also no longer reason for hesitancy in the admission of such a rank on the plea of imperfect knowledge of structure or the supposition that it may be the young of some other form †—a suspicion formerly common to many and shared by the author. With these facts, therefore, something more than mere assertion of opinion is requisite before the title of the group to at least class rank can be questioned.

A much mooted question has been what are the characters of the class of fishes, and how are they distinguished from the class of batrachians. This question has been discussed by Dr. Brandt, of St. Petersburgh, in an elaborate memoir.‡ So long as the fishes, Marsipobranchiates and Leptocardians, were confounded in one class, the extreme variations of the so-called class blinded one to the minor differences that would otherwise have been seized, and the result was that no absolute characters were discovered to limit the so-called class. But the class purged of the Marsipobranchiates and Leptocardians offers no longer such obstacles, and although the characters appear to have been overlooked hitherto, it is not the less true that all the known fishes are absolutely distinguished from all the known batrachians by very

* PARKER (William Kitchen), "On the Structure and Development of the Skull of the Common Frog (*Rana temporaria* L." [Phil. Tr. 1871, p. 202-3], well remarks "The lowest existing fish but one is the Myxinoid (lamprey, hag, Bdellostoma); between it and the lowest vertebrate, the lancelet (*Amphioxus*), there is a gap, the extent of which has never been imagined; and yet even the lancelet itself is not necessarily the boundary form. . . . . Every anatomist will at once see that a creature no higher in type than the unhatched embryo of the frog is yet an untold distance in advance of the lancelet which yet is only the *known lowest* of the great vertebrate subkingdom.

† BERT (P.) Sur l'Amphioxus. Note de M. P. Bert. . . . . <Comptes rendus hebdomadaires des séances de l'Académie des Sciences (Paris), t. 65, 1871, pp. 364-7; translated (On the anatomy and physiology of Amphioxus) <The Annals and Magazine of Natural History, third series, 20, 1867, pp. 302. Contains notes on the ejection of semen, etc.

KOWALEVSKY (A.) Entwicklungsgeschichte des Amphioxus lanceolatus. . . . 1867. [8vo. 1 pl., 17 pp. 3 pl.] < Mémoires de l'Academié Impériale des Sciences de St. Pétersbourg, viie Série, t. xi, no 4.

An account of the development of the species. The eggs are expelled through the mouth.

‡ BRANDT (Johann Friedrich). Bemerkungen über die Classification der Kaltblütigen Rückenmarkthiere zur Beantwortung der Frage Was ist ein Fisch? . . . . St. Petersburg, 1865 [4to. 1 pl., 30 pp.] = Mémoires de l'Académie Impériale des Sciences de St Pétersbourg, 7e série, t. 9, no. 3.

obvious ones. All the batrachians have a scapula (in the broadest sense) which is homogeneous, the only differentiation being in the simple ossification of parts and which is always confined to the side; on the other hand, in all the fishes the shoulder girdle has somewhat the form of the furcula (wish-bone) of a bird, and really forms a girdle behind the head, inclining forward and connected below, either by a median cartilage or directly, and a wholly differentiated element (answering to the paraglenal or coracoid * region of Batrachians), or elements, support the pectoral member. The Dipnoans (Lepidosiren, etc.) and all other fishes agree in this respect and differ from the Batrachians.

In conclusion the following analytical synopsis (extracted from the author's "Arrangement of the Families of Fishes," published by the Smithsonian Institution) will exhibit the principal characters which distinguish the several classes confounded under the name of Fishes. The characters used are supplemented by many others: —

CLASSES.

I. Skull more or less developed, with the notochord not continued forwards beyond the pituitary body. Brain differentiated and distinctly developed. Heart developed and divided at least into an auricle and ventricle.

A. Skull well developed, and with a lower jaw. Paired fins developed (sometimes absent through atrophy); and with a shoulder girdle (lyriform or furcula-shaped, curved forwards and with its respective sides connected below †), and with pelvic elements. Gills not purse-shaped. PISCES.

B. Skull imperfectly developed and with no lower jaw. Paired fins undeveloped, with no shoulder girdle nor pelvic elements. Gills purse-shaped. MARSIPOBRANCHII.

II. Skull undeveloped, with the notochord persistent and extending to the anterior end of the head. Brain not distinctly differentiated. Heart none. LEPTOCARDII.

* This is generally multiple, and its elements have been identified with the radius, ulna, and humerus (Owen = third bone of the fore-arm of Cuvier). In a special article, I have discussed these homologies.

† The shoulder girdle of the Elasmobranchiates appears to be homologous with the paraglenal or coracoid elements of the specialized fishes, the proscapula of the latter having been apparently first developed by exostosis in the Ganoids, and finally become preponderant while the Paraglenal became proportionately reduced.

NOTES ON THE HABITS OF CERTAIN CRAWFISH.

BY CHARLES C. ABBOTT, M.D.

In the course of a day's fishing during the past month of September, my companion and myself caught a large number of those lobster-like crustaceans, known everywhere as "Crawfishes;" and by zoologists, as either Cambarus or Astacus, the former differing from Astacus in having a more elongated body, "by the absence of the gill on the fifth pair of legs," and other slight differences, not noticeable except upon careful examination.

The crawfishes found in New Jersey all belong to the genus Cambarus; and of this genus, certainly three species, viz., *Cambarus acutus* Girard, *Cambarus affinis* Say, and *Cambarus Bartonii* Fabricius, are found either in the streams and ditches near, or in the Delaware River, at Trenton, New Jersey.

It is difficult to say which of the three species is the most abundant in the general locality we have named, inasmuch as they seem to prefer different streams; one being a plant-loving, one a stone-haunting, and the third, a mud-frequenting species. In their respective haunts, each is apparently as numerous as is either of the others in their chosen home.

During the past month (September), as a result of a thorough examination of many small streams, as well as of the Delaware River itself, we have found the *Cambarus acutus* to frequent running streams, which have masses of vegetation growing in them, the animal in question resting upon the plants, usually near the surface of the water. We have found since our collecting excursions, on carefully approaching clear, running streams, such as just mentioned, that this crawfish is to be seen resting on the plants always with the head directed down stream. If disturbed, they would dart backwards down to the roots, apparently, of the plant upon which they were sitting. After a lapse of about ten minutes they would return to their former resting-place creeping up the plant down which they had so suddenly darted tail foremost.

The *Cambarus affinis* is apparently *the* river species of this locality. We have been able to find it, as yet, only in the Dela-

ware River, usually frequenting the rocky bed, but also, in fewer numbers, on the mud-bottomed portions of the river. They are usually found resting under flat stones, well out from the banks of the stream, where the water is of considerable depth. Wherever the vegetation is dense, we have failed to find them; nor have we seen anything to indicate that it is a "burrowing" species.

Dr. Hagen, in his "Monograph of the North American Astacidæ," which work we have followed exclusively in identifying the specimens we have collected, says, on page 62, "The *Astacus limosus* Rafinesque (Amer. Monthl. Mag., t. 2, p. 42) from the muddy banks of the Delaware" is apparently the same species as *Cambarus affinis*. While we have no reason, really, to doubt the correctness of this assertion, we may say that the specimens we have collected during September were none of them from the "muddy banks," but from the *bed* of the river; although in such banks we found many crawfish, of a very different species, as we shall see.

The *Cambarus Bartonii*, it appears to us, is the one burrowing species of this locality. We have found in the deep ditches, with precipitous, muddy banks, a medium sized crawfish, that in most respects, accords with the species called *Cambarus Bartonii* Fabr., by Dr. Hagen, on page 75 of his Monograph.

We have purposely said "in most respects," inasmuch as there is a considerable range of variation between the many examples that we have collected. Dr. Hagen says of this crawfish it "is the most variable species; as yet I cannot find stable and constant characters for dividing them into three or four species, as Mr. Girard has done."

It is this species, we doubt not, that Dr. Godman found near Philadelphia, and has referred to, as follows, in his "Rambles of a Naturalist," which we find printed with the second volume of his "American Natural History," third edition: Philad., 1842. Dr. Godman says,—"I now returned to the little brook and, seating myself on a stone, remained for some time unconsciously gazing on the fluid which gushed along in unsullied brightness over its pebbly bed. Opposite to my seat was an irregular hole in the bed of the stream into which, in an idle mood, I pushed a small pebble with the end of my stick. What was my surprise, in a few seconds afterwards, to observe the water in this hole in motion, and the pebble I had pushed into it gently approaching the surface. Such was the fact; the hole was the dwelling of a stout

little crawfish or fresh-water lobster, who did not choose to be incommoded by the pebble, though doubtless he attributed its sudden arrival to the usual accidents of the stream, and not to my thoughtless movements. He had thrust his broad lobster-like claws under the stone, and then drawn them near to his mouth, thus making a kind of shelf; and as he reached the edge of the hole, he suddenly extended his claws, and rejected the encumbrance from the lower side, or down stream. Delighted to have found a living object with whose habits I was unacquainted, I should have repeated my experiment, but the crawfish presently returned with what might be called an armful of rubbish, and threw it over the side of his cell, and down the stream as before. Having watched him for some time while thus engaged, my attention was caught by the considerable number of similar holes along the margin and in the bed of the stream. One of these I explored with a small rod, and found it to be eight or ten inches deep, and widened below into a considerable chamber, in which the little lobster found a comfortable abode. Like all of his tribe, the crawfish makes considerable opposition to being removed from his dwelling, and bit smartly at the stick with his claws: as my present object was only to gain acquaintance with his dwelling, he was speedily permitted to return to it in peace."

There are some points in this pleasing description of the haunt of a burrowing crawfish that differ from the results of our own observations. It will be noticed that the principal description is of a "burrow" or hole in *the bed* of the stream, facing against the current. This is more in accordance with what we have noticed of the habits of *Cambarus affinis*, which species, however, appears merely to take shelter under stones; and the burrows of *Cambarus Bartonii*, so far as we have discovered them, have all been *in the banks* of the smaller streams and meadow ditches (and occasionally, a colony of burrows *in* the river bank, where peculiarly favorable), a little below the usual water line.

The crawfish that we have found inhabiting such burrows, located as we describe, besides showing anatomical specific differences, will thrive admirably, we find, in an aquarium, where the water is, of course, quiet; while both the others die very soon after being taken from their natural habitats. This fact, we think, is of itself quite sufficient to show a decided difference between a burrowing and a running water species, even if no anatomical variations could be traced.

Dr. Hagen refers to the quotation from Dr. Godman, speaking of the crawfish, of which the latter writes, as *Cambarus Diogenenes* Girard, and considers it to be the same as *C. Bartonii* Fabricius; although it seems to bear some resemblance to *C. obesus* Hagen, a southern and western species. One fact is certain, at least, that the specimens observed by Godman were in a stream near Philadelphia, a locality familiar to Girard. We have found no specimen about Trenton, New Jersey, that could be identified with *C. obesus* Hagen, although we have made very careful search, hoping to find more than the three species we have mentioned.

Crawfish are strictly omnivorous animals but, although excellent scavengers, do not feed wholly upon decayed animal and vegetable matters. We have frequently noticed that *C. Bartonii* in an aquarium breaks off the short stems of the common river-weed, and eats the main stem, after stripping it of its minute leaves. So too *C. affinis*, from beneath its sheltering flat stone, and *C. Bartonii*, in its safe burrow, will seize the minute young Cyprinoids, that pass up and down near the stream in such myriads, ever and anon peeping into the various little indentations in the banks. Such little fish when once fairly caught by the big, but by no means clumsy, "hands" of a Cambarus, have no chance of escape, and are soon torn in pieces and devoured.

Etheostomoids, or "darters," that habitually rest upon the bottoms of the streams they frequent, will usually take shelter underneath a stone, if one be near, when they are disturbed either by larger fishes, or by man. When a crawfish happens to have taken up his abode under such a stone, it is seldom that the frightened "darter" escapes. Often have we seen the common *Boleosoma Olmstedi* take refuge as we have described and found, on examination, a Cambarus quietly resting underneath the stone, with the luckless "darter" in his claws.

Having had our attention particularly called to these crustaceans, during the past month of September only, we have, of course, noted nothing of their breeding habits; but the very great numbers of very small specimens half an inch to an inch and one half in length that we have found, seem to indicate that the animal is of slow growth during the first summer of its existence; and on the other hand, we have failed to find any specimens of *C. acutus* more than four inches in length, the maximum size being six and three-tenths inches, as given by Dr. Hagen.

Dr. Hagen mentions six specimens from Essex (Co.?) New Jersey, however, that were smaller than the above figures quoted from his work, being, to use his own words, "Long. corp. 3 ad 4 inch." He thinks it quite possible that these may "belong to a different species (viz., *Cambarus Blandingii*), a South Carolina form.

The young Cambari, in September, seem to be fully as active as the adults, but do not frequent any given class of localities, as they wander about the beds of streams, creeping forward in a slow, awkward manner, and swimming backwards, when disturbed, with wonderful rapidity.

It has seemed curious to us, that we have found no dead specimens of crawfish. In what manner their unattractive bodies are disposed of after death we cannot imagine. We have tried, too, in vain, to find out their enemies; but have failed to do so. We should judge that if at all preyed upon, it must be when they are but a few weeks old. But what becomes of their adult dead? Do they, as birds are asserted to do, seek some hidden nook? or do they dig their own graves deeply in the mud, preparatory to the approaching dissolution, which they feel is near at hand?

The precise number of species of this crustacean, inhabiting the streams of New Jersey, we do not doubt, will prove to be more than the three that we have mentioned; but as yet these are all that we can readily distinguish among the many dozens that we have gathered in our immediate neighborhood. The differences that mark these species, according to Dr. Hagen, are found to be coexistent with our separation of the specimens, in accordance with the different classes of localities where found; we can therefore scarcely think that there is any error in asserting that the crawfish found in the neighborhood of Trenton, New Jersey, are respectively, *Cambarus acutus*, *affinis* and *Bartonii;* the first, a plant-loving species: the second, a deeper water, stone-haunting form; the third, a burrower in the muddy banks of ditches, small streams and, occasionally, of the river itself.

THE RATTLE OF THE RATTLESNAKE.

BY PROFESSOR SAMUEL AUGHEY.

I wish to contribute my observations on the rattlesnake, having been specially favored in opportunities for the study of this reptile.

Of all the articles that have appeared on the subject in the NATURALIST that by Mr. Putnam* appears to me to present the most satisfactory theory concerning the use of the rattles. I am satisfied that *one* of their uses is to bring the sexes together.

In July, 1869, I was engaged in surveying along the Logan river in Wayne County, Nebraska. After completing my contract I devoted a day to investigating the natural history of the neighborhood. While washing a collection of unios at the water's edge, I heard the familiar rattle of the Massasauga (*Crotalophorus tergeminus*). I quietly crept up the bank and cautiously looking over the level bottom I saw, at the distance of about thirty feet, a rattlesnake coiled up with head erect and gazing in an opposite direction from my position. Every three or five minutes the snake would cease rattling for a minute or more and then commence again. In about half an hour from the time that I first saw the snake I observed another rattlesnake approach the first one. Closer and closer the second one approached, until at length they met and indulged in a sexual embrace. I watched them for at least an hour and left them at last without disturbing them.

The next year at the Bow river in the same state I saw the same thing repeated under similar circumstances. In neither case could I ascertain whether it was the male or female that gave the call.

I am satisfied that the theory† that the rattle resembles the noise made by the Cicada, and that it is employed because of this resemblance to entrap birds, etc., is a mistake. I have been accustomed to the sound of the Cicada and the rattle of the rattlesnake from my youth, and soon learned to distinguish them, although there is betimes a striking resemblance between them. My familiarity with them was gained in my native state amid the Alleghanies of

* AMERICAN NATURALIST, Vol. VI, p. 693. † *l. c.* p. 32.

Pennsylvania. In the last week of June, 1869, I was on the Missouri flood plain in a dense timber in Cedar County, Nebraska. At the time there were many Cicadæ and multitudes of birds in the timber. One day I was sitting on a log, classifying a collection of flowers and plants. Suddenly I heard the well-known rattlesnake rattle. The snake was not more than forty feet from me. I could not have been the cause of its alarm as a large log lay between us and I had been quiet for nearly an hour. Even the Cicadæ were alarmed and disappeared, and soon not a bird was to be seen, but the rattling continued. Unfortunately, on the impulse of the moment, I killed the snake without waiting to see or learn the purpose of its rattling. Again I have noticed that the Massasauga, at least in Nebraska, is by far the most abundant far away from the timber, where the Cicadæ are rarely if ever seen.

These observations seem to me to point to the theory that the rattle calls the sexes together. In July, 1871, I was in the timber on the Missouri in Dakota County, Nebraska. I got sight of a Baltimore oriole (rare in Nebraska) which I was following as it flitted from twig to twig. As it swept near the ground a rattlesnake struck his highest notes and seemed to paralyze the oriole with fear. This snake was a Crotalus. The poor bird hovered near the snake and fearing that it might fall into its jaws I shot the reptile. This experience suggested the theory that perhaps an additional purpose of the rattle was to frighten its victims into submission and to protect itself by the terror it inspires from its natural enemies. However that may be, is it not a mistake to limit such a peculiar organ to any one single purpose? What is needed to determine definitely the natural history of the rattlesnake is closer and more accurate observation over a wide area, and by persons who are fitted by nature and education for such work. Unfortunately for science, the almost universal custom has been to kill the rattlesnake as soon as found, without waiting to learn its disposition and habits of life.

Once in the Dakota Nebraska timber I saw an attack of hogs on a rattlesnake. In a few minutes after the snake commenced rattling, three others made their appearance. They apparently came to the assistance of the first one, but all were killed by the hogs in a few minutes. Seven hogs were more than a match for four rattlesnakes. Here evidently the rattle was used to call for help. These belonged to the genus Crotalophorus.

COLOSSAL CUTTLEFISHES.

BY A. S. PACKARD, JR.

THERE is a prevalent opinion among seamen that the largest being that swims is a colossal squid or cuttlefish. As a matter of fact there are immense squids which range the high seas, often forming the food of the sperm whale. It is these gigantic animals which have on rare occasions been seen by fishermen and others, which have given rise in past ages to the stories of the kraken. This animal was supposed to be large enough to form islands in the sea, and the well-known hoax of Denys Montfort represents a "kraken octopod" in the act of scuttling a three-masted ship. The first authentic records of these colossal squids will be found in a forthcoming memoir by Professor Steenstrup, the distinguished Director of the Zoological Museum of the University at Copenhagen. From the proof-sheets and copy of the first plate illustrating it which he generously placed in my hands, I find several authentic cases of the occurrence of gigantic squids on the European coast. In the middle of the sixteenth century (1549) there was found at Malmö, in Sweden, a large squid, called monk fish or sea monk (sömunk), and designated by Gesner as *Monachus marinus*. We shall refer to this animal again.

In 1639, 1798 and 1853, specimens of gigantic squids, now preserved in the museum at Copenhagen, occurred on the north coast of Denmark, and in 1662 another animal of this sort, the *Ommatostrephes pteropus* of Steenstrup, portions of which are in Prof. Steenstrup's collection, was found on the coast of Holland.

The specimen found in 1853, on the shores of the Cattegat, was represented only by the horny beaks which were over four inches in length (about the size of the beak figured on page 93). This is described by Prof. Steenstrup under the name of *Architeuthis monachus*.

The most interesting discovery, however, was from the neighborhood of the Bahamas, in latitude 31° N., and longitude 76° W. Specimens of the horny jaws, hooks, arms, sucking disks and other parts of a cuttlefish over eighteen feet long, were brought

to Copenhagen by Capt. Hygom from this locality in 1855. This species was named by Prof. Steenstrup *Architeuthis dux.**

This kind of cuttlefish, called the hooked calmary, is found swimming on the high seas, being solitary in its habits, not going in schools as the common squid. The end of the body and an arm of one of these hooked calmaries, thought by Prof. Owen to have belonged to an individual six feet long, are preserved in the museum of the College of Surgeons in London where, owing to the kindness of Prof. Flower, we had an opportunity of seeing it. The arms of this calmary are provided with large hooks arising from the centre of the suckers, which must add a peculiar horror to the slimy monster. It was found by Banks and Solander, the naturalists of Cook's first voyage, near Cape Horn. It was named by Prof. Owen *Onychoteuthis Banksii.*

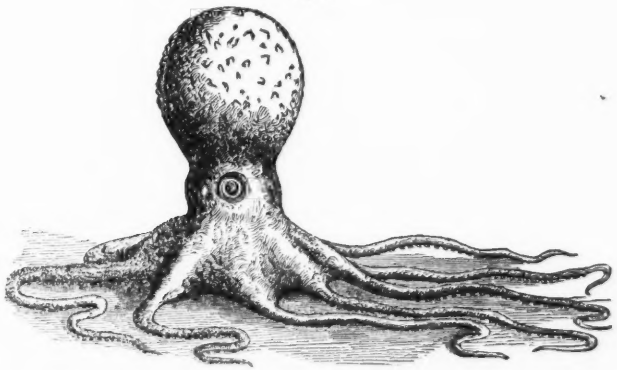
The French naturalists Quoy and Gaimard, as reported by Woodward in his "Manual of Mollusca," found a dead cuttlefish in the Atlantic under the equator, which must have weighed two hundred and twenty pounds when perfect. It was floating on the surface, and was partly devoured by birds. To the same excellent authority we are indebted for the statement that a kind of squid called the "sea arrow," used extensively for bait in the codfishery of Newfoundland grows nearly four feet in length. This possibly belongs to the genus *Ommatostrephes.*

We are indebted to "The World of the Sea" by M. Moquin Tandon, for the following statements regarding large cuttlefish. Pliny notices an enormous cuttlefish which haunted the coast of Spain devouring all the fish, and destroying the fishing grounds. It weighed seven hundred pounds, and its arms were more than thirty feet long. Aristotle speaks of a great calmar more than ten feet long which was taken in the Mediterranean. In modern times M. Verany speaks of a calmar a yard and a half long, and which weighed twenty-four pounds. One was caught near Nice, weighing fifteen pounds. An equally large one was found in the Adriatic, and its body is still preserved in the museum at Trieste. Over twenty years ago a calmar six feet long was caught off the south coast of France; it is still to be seen in the collection of the Faculty of Sciences at Montpellier. Peron, a French naturalist, met in the Australian seas a huge cuttlefish with arms more

*In the proof it is called A. Titan, but Prof. S. mentioned it to me in conversation as *A. dux.*

than eight feet long. Rang, in the same part of the world, met a cephalopod with a reddish body, which was the size of a ton cask. Swediaur reports that some whalers took out of the mouth of a whale pieces of a cuttlefish which were twenty-five feet long. On the 30th of November, 1861, the steam corvette Alecton, while cruising between Teneriffe and Madeira, encountered a monster cephalopod floating on the surface of the water. It was sixteen or eighteen feet long, irrespective of the eight long arms. The body was fusiform and weighed upwards of four thousand pounds. It is doubtful whether this creature was a true cuttlefish or not, but as its body is said to be fusiform and terminated in two fleshy lobes or fins, the two long arms may have been eaten off. The poulpes or octopods have no fins, and the body is a rounded mass, as seen in the adjoining figure, which represents a true octopus (a

Fig. 9.



Brazilian species), so that this was probably a cuttlefish.

I have been informed by Capt. J. Hammond of Salem, who has sailed for forty-one years between that port and the East Indies, that once, while off the Cape of Good Hope, he saw the remains of squid from eight to ten cubic feet in size, floating on the surface. The animal had apparently been attacked by whales and dolphins, and the arms and head devoured.

At a late meeting of the Boston Society of Natural History, Hon. N. E. Atwood related the fact that he had seen pieces of squid ten inches in diameter vomited up by a sperm whale, and that sperm whales were known to devour giant squid. I have re-

ceived the following letter from Captain Atwood reiterating these and other facts:—

"PROVINCETOWN, December 16, 1872.

DEAR SIR:—Your letter, asking me some questions about the size of the large squid of which I spoke in my remarks at a late meeting of the Boston Society of Natural History, was duly received. In regard to the large squid seen by whalers in every ocean where sperm whales are found, I would say that I think some of them are very large. I have made but one whaling voyage, and that was in the Atlantic, when I was a boy fifteen years old. I have not seen a piece of large squid since. I think I did then see some heads that were at least ten inches in diameter. Some of our whalemen here who have had many years' experience in whaling say they have seen them much larger than ten inches, but I find no one who has measured them, therefore they cannot give me anything definite in regard to their size.

It is the opinion of almost all whalemen that the sperm whale feeds wholly on squid. I have been informed by some of my neighbors (who are reliable), that they made a voyage in a schooner from this port, and when they were killing a large sperm whale, it threw up a shark some ten feet long. This is the only instance that I have ever heard of sperm whales eating anything but squid.

I refer you to Lieut. Maury's "Sailing Directions," in which he records several letters from whaling captains who have had much experience in the business, from which I make the following extracts:—Captain Daniel McKenzie of New Bedford says, 'The principal article of food (and indeed the only one as far as I know) is squid; the smaller kind they eat is found near the surface, and is from two to three feet in length; the larger kind, which probably have their haunts deep in the sea, must be of immense size: the flesh soft and of gelatinous substance. I have seen very large junks floating on the surface entirely shapeless.' Captain Francis Post says 'Cuttle or squid, supposed to be the only food which sperm whales ever eat, are often found in shoal water; there is, however, a species of this fish, the exact size of which is not known, but it is presumed to be large, as whales in the agony of death frequently eject from their stomach pieces as large as the bulk of a barrel, and these in large quantities; so that the assertion of the naturalists that the whale, though the largest of animals, is one of the smallest eaters, is untrue. Large pieces of squid are often seen floating on the sea, which whalers consider indicate good whale ground.' Capt. Roys writes to Lieut. Maury, dated Hong Kong, January 19, 1851: 'The sperm whale is found in all climates, and in every sea; he feeds upon an inanimate animal substance called a squid, which grows upon the bottom of the sea, and is never seen upon the surface, except

when torn up by the whale. I have seen it in large pieces floating upon the surface. I have seen a dying whale vomit it up. I have opened the stomach of a whale and seen it there in pieces, which convinces me that the animal is very large also, as well as small; and that the sperm whale almost always when in want of food goes to the ocean bed.' Captain Rose, of the bark Dove, writes under the date of June 1, 1854, as follows: 'Fifteen years ago I might have agreed with Captain Roys, that sperm whales' feed [*i.e.* squid] lived or grew on the bottom of the sea, and it may live there; but as to its never being seen unless torn up by whales, I know and can support the assertion that in some seasons and places it is seen on the surface of the water both alive and kicking. I have seen them often on the southeast coast of Arabia, mostly in the morning, dodging across the bows and in the wake of the ship.'

The above extracts will show you that the whalemen, who have have had much experience, give us nothing definite in regard to the size of the squid."

In confirmation of this and other statements to the same effect, we may cite a similar statement from an old whaler, given in Prof. Shaler's article on the "Habits of the Sperm Whale," on page 3 of the present volume of this journal.

It now remains for us to notice briefly the facts regarding the colossal squid that have come under our own notice. In the autumn of 1871 appeared a statement in the "Cape Ann Advertiser" that the crew of a Gloucester fishing vessel, while upon the Grand Banks, found a squid, floating dead, which measured fifteen feet in length and four feet six inches in circumference, the longer arms measuring ten feet. On writing to the editor, and inquiring how far this statement could be relied on, he kindly wrote in reply as follows:—

"The account of the squid, as published in the "Advertiser," is correct, and is vouched for by Mr. James G. Tarr, of the firm of Dodd, Tarr & Co., of East Gloucester. The squid was picked up afloat (dead) at the place mentioned, and was so large that they had to take their tackle to get it aboard the vessel. They cut up one-half to bait their trawls, and caught with it one hundred quintals of fish. The skeleton might have been brought in as well as not; but sailor-like, they did not think of it."

From Mr. Tarr I also received the following letter, giving more precise details:—

"East Gloucester, January 4, 1872.

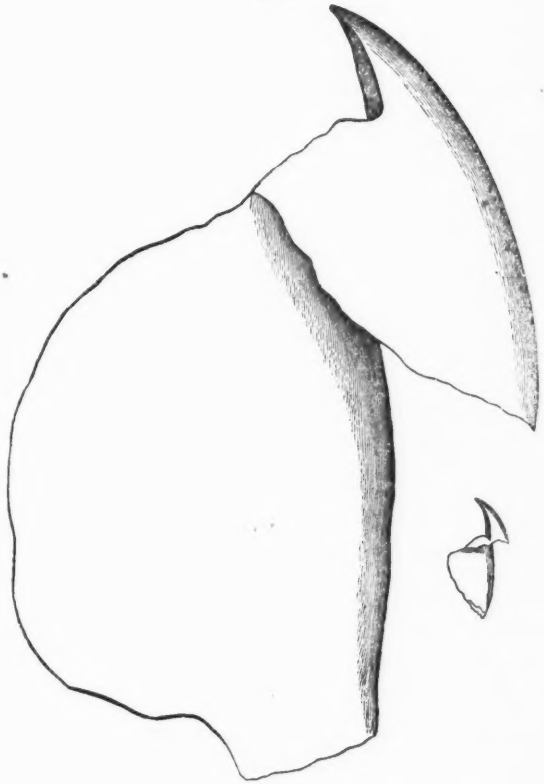
Your note of the 22d ultimo came duly to hand. In reply I would say that Captain Campbell of the schooner B. D. Haskins,

while lying at anchor on the Grand Banks on or about the 20th of October, discovered something floating on the water, perhaps a gun-shot from his schooner. The weather being fine and pleasant he ordered the boat lowered, and sent two men to learn what it might be; they returned reporting the object to be a mass of floating jelly, or something unknown to them. The Captain then with hooks and gaffs and more men went to investigate; he found it quite dead, each end hanging under water, only the centre on its surface. After towing it alongside the schooner, he took his purchase or halyards to hoist the monster out of water, and on seeing its head, declared it to be a squid, saying he had heard of squid of that size, but never saw the like before. After it was got on board, the second hand or mate informs me he measured the body with a rule and found it fifteen feet long, four feet eight inches round. The long arms were badly eaten; judged they might be nine or ten feet long; two were shorter than the former, perhaps two or three feet; did not measure the arms, but judged them twenty-two inches round; also judged its weight to be two thousand pounds, and would fill eight or ten barrels. The biggest squid usually found on the banks is about one foot long. Enclosed I hand you the size or form of one of its beaks or bills. The original is in the hands of one of our workmen who declines to part with it. I learn from some older fishermen that years ago large squid were often taken on the Grand Banks, and whalers have often seen them in northern oceans of immense size, larger than any whales. One old gentleman has seen an arm taken from a captured whale that measured forty feet in length. I think the large squid is often found in the northern oceans."

Learning from Mr. Tarr that one of the crew had the horny jaws of the monster in his possession, I offered him a fair price for it for the museum of the Peabody Academy of Science, but he would not part with it. Through the kindness, however, of Mr. Tarr, I was enabled to obtain an imperfect photograph of it. The beak had been split open and spread apart, and photographed in this position. I took a photograph of it to Prof. Steenstrup who kindly spent some time with me in endeavoring to identify it from the specimens in the unrivalled collection of decapodous cephalopods in the museum of the Royal University. He decided that in all probability, so far as could be decided from such imperfect data, the beak must have belonged to the *Architeuthis monachus* Steenstrup. This is the "sea monk" which we have previously noticed as having occurred on the coast of Cattegat in 1853, and which was also known to the naturalist Gesner, who wrote in the middle of the sixteenth century. I also showed Prof. Steenstrup

the proof of the accompanying cut (Fig. 10), of the beak of a squid, which was presented by Hon. N. E. Atwood to the Essex Institute several years ago. It is four and a half inches long, the cut being of the natural size. The specimen was taken from the

Fig. 10.



stomach of a sperm whale, captured in the North Atlantic, and is now in the Museum of the Peabody Academy of Science. Judging by this cut, Prof. Steenstrup ventured the opinion that it belonged to *Architeuthis dux* which, as we have stated above, has been previously found near the Bahamas. He also suggested that the

smaller figure (natural size) in the cut, illustrated the beak of another small squid, the *Gonatus Fabricii*. A beak of this squid was presented by Captain Atwood at the same time with that of *A. dux*, and we suppose it may have come from the same sperm whale, but there is no statement to that effect. These specimens will all be sent to Prof. Steenstrup for accurate determination. When his memoir appears we hope to be able to present our readers with a more satisfactory account of these, until lately almost fabulous, monsters of the deep. I may however not be trespassing on the kindness of Prof. Steenstrup if I say that I had the pleasure of examining a squid, perfectly preserved in spirits, with arms about twelve feet long; the body as well as I can remember being between two and three feet in length, which he had just received from Iceland. Its discovery has undoubtedly before this been announced in Danish journals.

We have said nothing of colossal Octopi, or poulpes. We published an account of one, however, in the last number of the NATURALIST (page 772) which had been found at the Bahamas. The daily papers had a notice of one thirty feet in length, seen near Newfoundland during the past summer, but much allowance must probably be made for the statement. Prof. Brewer, of Yale College, tells me that he has seen them measuring fourteen feet from tip to tip of the expanded arms in the San Francisco markets. Accounts of colossal species of Octopus are not uncommon. They occur in the mid-Indian, Atlantic and Pacific oceans, and seem to be as large and much more common than the ten-armed squids.

ON THE POTTERY OF THE MOUND-BUILDERS.

BY J. W. FOSTER, LL. D.

In the specimens of pottery which have been recovered from the mounds, there is displayed a skill in the selection of the materials, and in the moulding of them into artistic forms, which far surpass the specimens which are characteristic of the Bronze Age of Europe. The commonest forms represent kettles, drinking cups, water-jugs, pipes and vases in the nature of sepulchral

urns. The Mound-builders, not content with plain surfaces, often decorated the exterior of the vessels with scrolls, chevrons and indentations; they even went further, and modelled the effigies of birds, animals, and of the human form. The clay, except for their coarsest utensils, such as kettles, etc., where gravel was often introduced, was finely tempered, so that it did not warp and crack in burning,—the utensil when completed having a yellowish or grayish tint. Most of their pottery was unglazed; but in one instance, hereinafter to be described, the additional process of glazing was resorted to.

Water-jugs.—These utensils are quite abundant, and appear under a variety of forms. Being unglazed, they would permit water to permeate slowly through the pores, and thus, by evaporation, produce a temperature below that of the surrounding air,—a device resorted to, at this day, in tropical climates, to keep water cool.

Fig. 11.

Water-jugs from Perry County, Missouri. = ⅛.

The subjoined figure represents two water-jugs, which are similar in shape to the decanters formerly furnished the guests of a hotel, before the days of water-works. They were taken from an ancient cemetery in Perry County, Missouri, and were found occupying a position near the head of a corpse. Height, 8 inches.

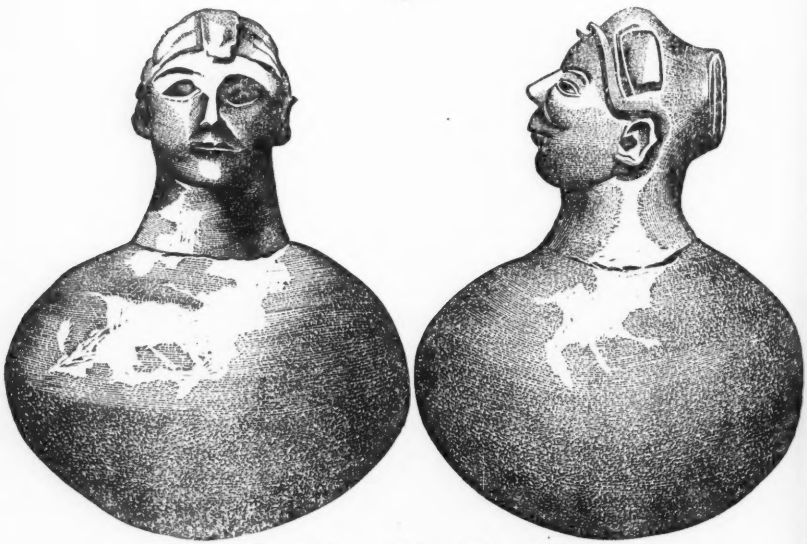
Figure 12 represents a fine specimen of ancient modelling. The body consists of a compressed globe, surmounted by a human head. The orifice in the region of the occiput, is about half an inch in diameter; the height of the figure is 8½ inches.

When we examine this head critically we are convinced that the unknown artist had the skill to impress upon the plastic clay the features of his race. Those features are not characteristic of the Red man. The facial angle is not as obtuse as in the European; the eyes have not the obliquity of the Indian; the jaws are not extraordinarily prognathous, and altogether, the contour of the face is indicative of intelligence. The head is covered with a fillet, the material of which was probably cloth. Have we in this model the characteristic features of the Mound-builder? It is not

a caricature; there is nothing grotesque; but there is a display of artistic skill which could impress upon the clay whatever type the modeller had in his mind.

Figure 13, on the next page, represents a profile and back view of a statuette. His head is covered with several plaits of cloth; his eyes are closed; his face is contorted, as if in pain; his arms are pinioned with a strong cord; the bones and muscles of his shoulders are brought out in strong relief; and while these points are well delineated, the lower extremities are grossly incongruous.

Fig. 12.



Water-jug from near Belmont, Missouri. = ½.

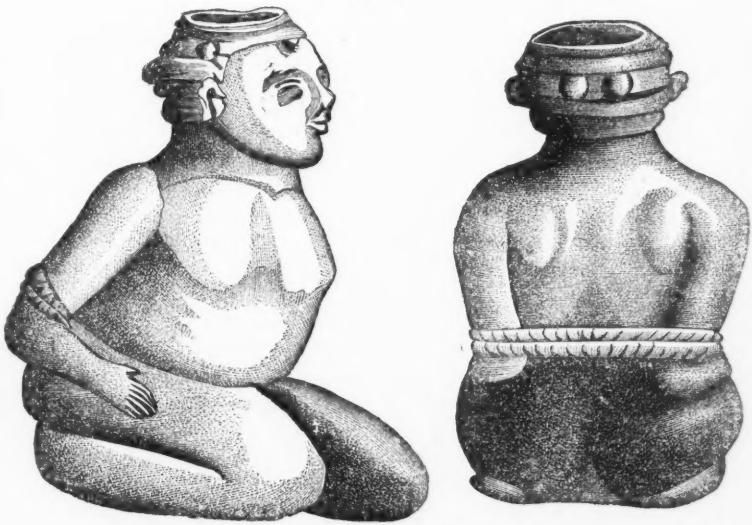
This figure may have been designed to commemorate the capture of some dangerous enemy, or some notorious malefactor; or, as it is now pretty well ascertained that the Mound-builders offered up human sacrifices, it may represent a victim prepared for the altar. There is an opening at the top of the head, and the marks of the gouge with which the superfluous clay was extracted are plainly visible. Height, 8 inches.

These two vessels last described were exhumed by the late Sylvester Sexton, of Chicago, from a low mound in Mississippi

County, Missouri, about seven miles from the battle ground of Belmont. There was also found a plain water-jug, of about the capacity of that described as Figure 12. Statuettes of a similar character, but less artistically executed, are in my possession from the ancient cemetery in Perry County, before referred to. In all instances they were found near the head of the corpse, and appear to have been offerings consecrated to the dead.

The Wabash Valley, throughout its entire course, appears to have been a highly favored region to the Mound-builder. About

Fig. 13.

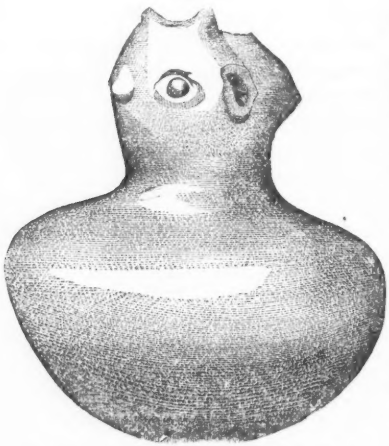


Statuette from near Belmont, Missouri. = ½.

twenty miles above the mouth of this stream, on the Indiana shore, there is a high bluff, the site of an ancient cemetery, in which great quantities of human relics from time to time have been unearthed by the excavating power of the river. Among these may be enumerated bones, ash-heaps, stone-axes and arrow-heads, and pipes and vessels of pottery. At a point still further south, was recovered a water-jug which in its general outlines is similar to that from Missouri (Fig. 12). Figure 14 is a representation of this utensil, the height of which is 6 inches.

It is difficult in this figure to determine precisely what the artist designed to represent, but the nearest approach among the feathered tribe would be the horned owl. The eyes are large and circular, the beak is short and divided, the head is crowned by two projections which may be taken for tufts of feathers, and yet to the cheeks are attached the appendages of human ears, which are pierced for the reception of ornaments.

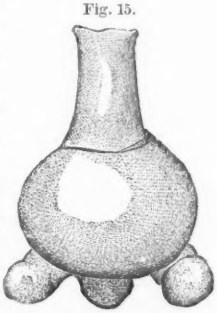
Fig. 14.



Water-jug found near the mouth of the Wabash by David Septer, and presented to Prof. Cox of Indianapolis, by Dr. J. W. Berry. = ¼.

It is not often that we meet with vessels supported by feet, yet a few such instances occur. Figure 15 is a representation of one belonging to this class, which was found in a ploughed field, near Belmont, Missouri, by William J. Hough, of Paducah, Kentucky, and kindly loaned by the present owner, Daniel Hough, of Indianapolis, for this illustration. This attachment is common in the ancient pottery of Mexico and Central America.

Fig. 15.



Water-jug from near Belmont, Missouri. = ¼.

For the purposes of comparison, I introduce the figure of a vessel from San José, near Mexico (Figure 16), one of a series forming the Scammon Collection of Ancient Pottery, belonging to the Chicago Academy of Sciences. It is symmetrically moulded, and is of a uniform reddish tinge, which would indicate that it was burned in an oven, rather than in the open air. What is particularly noticeable, in view of what I shall state hereafter, is the series of *chevrons*, or small triangles, with which the rim is decorated. This chevron

mode of decoration appears to have been widely prevalent, and not confined to this hemisphere. The most beautiful specimen of ancient pottery of the Mound-builder epoch, which I have ever seen, was a cup recovered from a shell bank on the borders of Grand Lake, Louisiana, by Dr. Dungan, of Jeaneret's, and deposited in the collection of the Chicago Academy of Sciences, but unfortunately destroyed in the memorable fire of October 8, 1871. It was hemispherical in form, and glazed with a pigment of a rich umber color, except where ornamented, in which the groundwork was reddish. This is the only instance of *glazed* pottery, which, to my knowledge, has been found on the Gulf coast. In the accuracy of detail and in the graceful lines of the contour, this vessel reminded me strongly of the best specimens of Japanese pottery of the present day. The rim was ornamented by the same system of chevrons seen in the preceding specimen, with this addition, that below the line defining this work there was a scroll-like border of harmonious outline. At first I was disposed to regard this similarity of marking as a signal fact demonstrating a filiation between the ancient inhabitants of the two regions, but I

Fig. 16.

Ancient vessel from San José, near Mexico. = ½.

Fig. 17.

Pottery of the Bronze Age, Switzerland. = ½.

Fig. 18.

Drinking cup from an ancient grave, Perry County, Missouri. = ¼.

Fig. 19.

Pipe from a Mound near Laporte, Indiana.

subsequently found that precisely the same device was used by the people of the Bronze Epoch of Switzerland, as will appear from the accompanying illustration (Fig. 17), which is a reproduction of figure 27 *a*, as given by M. Desor, in his paper on the "Palafittes of Lake Neufchatel."

Drinking Cups. — These relics often display much taste in form and ornamentation. Figure 18 is a representation of one found in the ancient cemetery in Perry Co., Missouri, before referred to. It will be seen that there is a flat lip attached to the rim, and that the handle is surmounted by a female head. In the occipital region there is a small orifice leading to a larger cavity which, at the time of the discovery, was filled with pellets. These, the discoverer supposed to be pills. This is one of the most beautiful specimens of antique pottery which it has been my fortune to observe. The clay was properly tempered, showing a homogeneous mixture, and the body is of as uniform thickness as though turned on a

Fig. 20.

Urn from a Mound near Laporte, Indiana. = ¼.

Fig. 21.

Fig. 22.

Sepulchral Urns from the Mounds near Laporte, Indiana. = ¼.

potter's wheel. The general form is graceful, and the female head is far from being a caricature.

Pipes. — Under this head I give an example (Fig. 19), by way of illustration, for the reason that here we have the human countenance moulded with some degree of artistic skill. In the stone

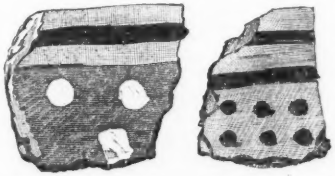
sculptures, representing this class of implements, we have the highest type of the Mound-builders' art. The narrow, receding forehead, the broad cheek bones, caused by the outward sweep of the zygomatic arches, and the projecting jaws,—characters which appertain to the inferior races—are here represented. This is about the only instance of an obscene figure (the posterior extremities are omitted) which I have observed.

Fig. 23.

Urn from an Ancient Grave, Greenup County, Ky. = ¼.

Sepulchral Urns. — These are quite numerous, and are often graceful in form, and elaborately decorated. Not unfrequently there is found at the bottom of them a dark carbonaceous matter which may be the residuum of the food which they contained when placed at the head of the corpse. I give three illustrations (Figs. 20, 21 and 22) of this class of utensils, taken from the mounds near Laporte, Indiana, by Dr. Higday. In one the material is a finely tempered clay, and the thickness of the walls is so uniform, that I have been led almost to the belief that it was turned on a potter's wheel. The other two are of a coarse texture, and the ornamentation is less skilfully accomplished. The curved lines appear to have been traced by a sharp-pointed instrument, and the indentations to have been punched by a square-pointed one, when the clay was in a plastic state.

Fig. 24, *a*. Fig. 24, *b*.



a, Ancient Pottery from Merom, Indiana. *b*, Ancient Pottery from New Mexico (Prof. Cox's Collection).

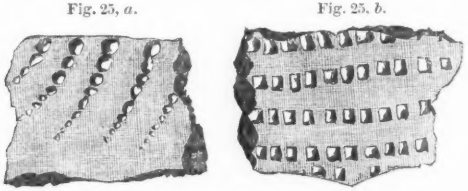
The urn, represented in figure 23 is in Professor Cox's Collection, and was taken from an ancient grave near the mouth of Big Sandy River, Greenup County, Kentucky. It differs from the others represented in having handles, and the ornamentation consists of a series of corrugated lines, vertically disposed.

Kettles. — On the borders of the Saline River, Gallatin Co., Illinois, according to the manuscript notes of Professor Cox, Director of the Geological Survey of Indiana, and kindly placed at my disposal, there issues a salt spring which was resorted to in the earliest settlement of the country by those of European de-

scent for the purpose of procuring salt by evaporating the brine. The Indians, according to Cotton Mather and other authorities, never employed salt in curing their meats, but resorted to the process of drying and smoking; yet here occur in abundance, fragments of pottery, showing that a prehistoric people visited this spring for the purpose of "boiling salt." From the slight curvature of the fragments, it is evident that the vessels were of large capacity. The material is coarse; the general thickness of the walls is about half an inch in diameter, but becomes thicker about the rim. The external markings consist of vertical lines of depression, half an inch apart, with lines sometimes horizontal, and at others oblique, so that I am inclined to believe that in moulding these large vessels, they constructed a wicker-work of rushes to sustain the clay until it had become dried.*

It is rare to meet with vessels which are decorated with colors,

Fig. 25, *a*. Fig. 25, *b*.



a, *b*, Specimens of Pottery from Aztalan, Wisconsin.

yet such relics are found at Merom, Indiana (Fig. 24, *a*), in this respect resembling the pottery collected by Prof. Cox, west of the Rio Grande in New Mexico (Fig. 24, *b*). In both instances the fragments are marked by broad stripes of black around the rim, while the body is ornamented with circular spots; with this difference, however, that in the one instance, the effect is produced by a dark background, while in the other the process is reversed. Professor Cox informs me that the Indians of New Mexico colored their pottery black, by using the gum of the *mezquite*, which has much the appearance and properties of gum arabic, and then baking it, by which the mordant became set. Much of the pottery from the Colorado Chequito is colored, the prevailing tints being white, black and red.†

* Since this article has been in type I have seen a paper by Mr. Charles Rau, in which this pottery is spoken of, and the same views expressed as to its mode of manufacture.

†Vide "Pacific Railroad Reports," Vol iii. Whipple's Report on the Indian Tribes, p. 48.

The pottery found at Aztalan, Wisconsin, is of a coarse texture, and crude in its ornamentation, like that of the European Stone Age.* In the first example (Fig. 25, *a*) the ornamentation is effected probably by a twisted band pressed into the plastic clay; and in the second example (Fig. 25, *b*), by a square-pointed instrument, similar to that used by the Laporte Mound-builders (Fig. 20).

It may be remarked in the nature of a generalization, that in the region of the confluence of the Ohio and the Mississippi as the supposed centre of the Mound-builders' empire, the pottery is composed of much finer-tempered materials, is distinguished by a greater variety of form and outline, and the artistic conception is of a far higher range and fidelity of execution than are to be found in the specimens from what may be regarded as the frontier regions of Wisconsin, Northern Indiana, and Northern Ohio.

I have said in the introduction to this article, that the Mound-builders, in the selection of the materials, and in the moulding of them into artistic forms, were far in advance of the inhabitants of the Bronze Epoch of Europe. The evidence on which that opinion is founded is contained in the illustrations which I have given. While the inhabitants of the European Bronze Age were content, in their artistic delineations, with simply curved lines and chevron-like markings, the Mound-builders adopted not only the bold swell of the scroll-like ornamentation, but grappled with the delineation of the human figure and human face,—the highest perfection of art; and in this range of modelling, it will be admitted, from the examples submitted, that they soared far above mere caricature,—that they imprinted upon the plastic clay the characteristic features of their race.

* Specimen *a* is almost identical in its markings with those on ancient pottery from West Kennet, England (*Vide* Lubbock's "Prehistoric Times," p. 162, fig. 154). Compare this also with specimens of pottery from New Jersey, given by Abbott, fig. 86, in the AMERICAN NATURALIST for April, 1872.

REVIEWS AND BOOK NOTICES.

THE EMBRYOLOGY OF FOSSIL CEPHALOPODS.*—This essay contains some of the results of several years' study of the rich collection of fossil Cephalopods contained in the Cambridge museum. The special investigations recorded here were made for the purpose of ascertaining the limits of the embryological period among the typical Ammonites. In order to do this the author made sections of the shell and worked out the form of the embryo or young animal just after being hatched. This may be detected by breaking away the older whorls, and getting at the minute globular sac, which represents the shell in its first stage. This sac may be found in Ammonites and Goniatites, but in the shell of Nautilus it is not retained, though "traces of its former existence are apparent on the apex of the first whorl in the form of a scar or cicatrix. Into this sac opens the first whorl of the shell; other whorls are added, until they form a long series coiled up closely, as in the Ammonites so familiar to geological students." As is well known to palæontologists there are all grades of form from the "straight Orthoceras to the coiled Nautilus, and inversely, among Ammonoids from the closely coiled Goniatites and Ammonites to the straight Baculites; the general morphology being readily and accurately expressed as a coiling up of a straight cone, and the subsequent uncoiling of the same at later stages of the earth's history. The shells are almost universally classified in accordance with this coiling and uncoiling, with which also the structure of the siphon and septa are more or less correlated." Prof. Hyatt has endeavored, and we think with great success, to show that this series of forms is epitomized in the life of the individual Nautilus or Ammonite. The young in these Cephalopods are at first uncoiled like some genera, and the different degrees of coiling up find a permanent expression in the genera of Ammonoids.

He figures the embryos of certain Goniatites, and from the differences presented by them, a succession of forms is detected which accords with what we know of the morphology of these Cephalopods and their geological succession. He concludes that—

* Fossil Cephalopods of the Museum of Comparative Zoology; Embryology. By Alpheus Hyatt. (Bulletin of the Museum of Comparative Zoölogy, Cambridge, Mass., vol. iii, No. 5. Cambridge, 1872. 8vo. pp. 116, with cuts and four lithographic plates.)

"The range of form has been among the Nautiloids from the straight Orthoceratite through intermediate arcuate genera, to the partially coiled Lituites, and finally the closely coiled Nautilus. Such being the case, if there is any truth in the doctrine of evolution, we must expect to find some reference to the peculiarities of the parent Nautiloid stock in the earlier stages of development among the Ammonoids. And further, as a direct and unavoidable corollary of the above, we ought to find this reference more distinct in the young of the earlier species of Ammonoids, the Goniatites of the Silurian, and less noticeable in Goniatites of the Devonian and Carboniferous, and, finally, almost obliterated, or at any rate, still less distinct in the typical Ammonites of the Jura. So far as the facts have been ascertained, they all point in this direction. The simple Nautiloid-like Goniatites of the Silurian may exhibit an Orthoceratitic or straight form, or be closely coiled in the young of different varieties of two distinct species. A species, therefore, on this horizon, may have a range of variation in form, during the earlier stages of development, equivalent to that occurring among the adult forms of Nautiloids from Orthoceras to Lituites. We find in this a perceptible acceleration in the development of the young precisely proportionate to the estrangement, either in time or in adult organization, of the Ammonoids from their supposed parent stock. There are evidently two tendencies at variance with each other: one strongly reversionary, appearing in the frequency with which the earlier Goniatites repeat the parent form in certain isolated instances in the young of varieties, and in the different species of the later Goniatites manifesting itself in the arcuate cone of the young of *Goniatites compressus* and others of the Nautilini, and in the closer, though non-involute, coiling of the young of other forms. Evidently this tendency is losing its power to affect and modify the organization, or, in other words, its prepotency. The other tendency, which is expressed in the closer coiling of the whorls, and finally in their increasing involution, is decidedly progressive, increasing in power to the final and ultimate extinction of all reference to the ancestral type, except in the internal organization. Here, as will be shown, the siphon for a limited time remains central in the first whorl, and the first septum has a large entire abdominal cell, and simply concave lateral lobes, as in the Nautiloids.

The form, however, of the first whorl of the Ammonoid is like Goniatites, the shell similar, and the second septum has the invariable abdominal lobe, superior lateral cells, and lobes of the simpler adult Goniatites, but not by any means of the simplest Goniatites. The simplest adult Goniatites have no proper lateral cells, but only broad lateral simple curves to the septa, as if the first septum of the Ammonite was modified or broken by a small abrupt lobe on the abdominal side. Contrast this with the development of the septa, and their gradual change in *Goniatites com-*

pressus, and we see at once that the development of the same parts is very much quickened or accelerated in the typical Ammonite.

That this acceleration of development is due to the prepotency of the same progressive tendency as the closer and closer coiling, and final involution of the ovisac, by the first whorl, can hardly be doubted. Thus, not only in the whole series of Nautiloids are the forms more or less completely coiled and finally enveloping, but in the young Ammonoids this process is repeated, but only as a reversionary tendency of individuals and species, or at most, perhaps, by the group of Nautili."

Our author finds that all the typical Ammonites may be resolved into natural series. As bearing upon the question of mimetic forms, we may refer to the observation that the above noticed series "contain more or less representative or mimetic forms due to the resemblance occasioned by the amount of the involution or the characteristics which are usually correlative with the amount of involution." He also indicates the effects upon the individual and the group to which it belongs of the changes due to old age, which have not been sufficiently taken into account by observers.

"When, however, the organization of the group no longer progresses, but retrogrades by the uncoiling of the whorls in Scaphites, Ancycloceras and Baculites, repeating—as shown by several authors, but notably by Barrande—the earlier forms of the Nautiloids in inverse order, these, though strictly mimetic, are produced by the encroachment of senile characteristics. These are observed in the old age of such species as *Ammonites Humphriesianus*, where the old whorl becomes smaller, more cylindrical and, if growth was continued, must eventually strike off from the regular spiral as in Crioceras or Lituites. This irregularity is found at earlier and earlier stages of growth, and finally affects the whole form as in the completely straightened Baculites. Direct inheritance of senile characteristics is not claimed, but merely that retrogression of the individual in old age and the retrogression of the group are similar, and both due probably to the same cause, exhaustion of the powers of growth."

As an example of Cope's law of "retardation" in accounting for the origin of distinct forms, Prof. Hyatt cites the case of the spiral or Gasteropod genus Turrilites.

"The young of several species of typical Ammonites often assume the spiral, although this is entirely suppressed at a later stage, and the succeeding whorls resume the normal mode of growth and revolve in the same plane. When, therefore, the normal mode of development is "retarded," we find even in the adult this Turrilites-like condition of the young, which is as truly reversional as the

Orthoceratitic young of *Goniatites fecundus*. This happens occasionally in the lower Jura, and finally, after the progressive stage of the whole order passes its climax, in the lower and middle Jura, we find the development of a whole group affected by this retardation, and the spiral is common to several generic forms."

We believe that the author is on a line of investigation bearing most intimately not only on the origin of organic forms, but also on a question next in importance, the law of their extinction. How an animal or plant is produced is a matter of the greatest interest, but is not the cause of its decay and death one almost as interesting?

Since the present essay was published the author has gone to Germany to study the collections of fossil Cephalopods in the museums of Hanover, Stuttgart, Tubingen, etc. From a recent letter we take the liberty of quoting some remarks which confirm the conclusions of his first paper on this subject,* and of the treatise before us.

He took as a test of the whole order the family of Arietidæ, which are confined to one formation, the lower Lias.

"It is simply wonderful to see how perfectly the geological position of each species in the formations here agrees with its place in the series as determined by development. The successive minor formations of the lower Lias are nothing more than successive faunæ. They are the smallest divisions that it is possible to make in the geological series of rocks, and yet there is no more confusion than results from one species passing by another, or living longer.

Thus *a* may live longer than *b* and appear along-side of it, but the young of *b* is like the adult of *a* always. Now, then, I think we can depend upon development to give us the laws of descent, and not only that but more. In fact I feel sure that I can give the reason why one entire fauna is different from the next, or that which preceded it, and why also the species on the same level have some common characteristics. This is the legitimate

Obtusus bed.	*a b*
Angulatus bed.	*a*

* On the Parallelism between the different Stages of Life in the Individual, and those in the entire group of the Molluscous order Tetrabranchiata (Memoirs of the Boston Society of Natural History Vol. 1. Part 2. 1867). The characteristics of the period of decline of the individual cephalopod shells have been discussed by D'Orbigny. This idea is extended by Hyatt to include the collective life of this order of the class of Cephalopods, during the geological periods in which the order came into existence, culminated, and then declined and went out in forms both reminding us of the embryos of the Nautilus and Ammonite, as well as the earliest generic forms of the order. Thus according to Hyatt's theory the different stages of the life of the individual Nautilus or Ammonites accord with those of the collective life of the entire order.

result of the developmental theory, and must be so, if we can compare the growth of an individual to the progressive existence of a species or a group in time. To do this, however, my old age theory becomes almost as important as development itself, or else the entire period of decline in the different groups and series, and many characteristics of their early beginnings, as well as the resemblances which exist between the forms at the beginnings and at the ends cannot be accounted for. In fact I am now sure that the proportions between the different periods of the life of any one individual may be compared with accuracy to the life of the group to which it belongs; in youth to what the group is in the beginning, in the adult to what it is now, and in old age to what it is to be in the future."

Another point of interest that engaged the author's attention was the discovery of the ancestral form of the Tetrabranchiate Cephalopods. Such a form he is disposed to think occurs in Endoceras. Giving his reasons in full he concludes that "it is in this group, therefore, or in some closely associated genus, that we must look for the ancestors of the Tetrabranchiate Cephalopods." The genus is a subdivision of Orthoceras (belonging to the group Vaginati), a straight-shelled Cephalopod figured in all the text-books. Barrande's opinion is also cited. That distinguished palæontologist has also "settled upon Ascoceras as the prototype, regarding the Vaginati as the nearest allies of Ascoceras."

We may safely say that this is one of the most thorough palæontological essays that have appeared for many a day. The author seems to have had unusual facilities for study, as he acknowledges his indebtedness to the liberal views pervading the management of the museum by which he was allowed to break up valuable specimens in the course of his investigations. The four lithographic plates illustrating the present Bulletin are exquisite.

Life Histories of our Butterflies and Moths.* — These are carefully elaborated accounts of the metamorphoses of some of our common moths (*Sesia diffinis*, *S. Buffaloënsis*, *Thyreus Abbotii*, *Philampelus Achemon*, *Smerinthus geminatus*, *Daremma undulosa*, *Platarctia Parthenos*, *Euprepia Americana*, *Euchætes egle*, *Lagoa crispata*, *Hyperchiria Io*, *Eacles imperialis*, and *Anisota senatoria*) which in some cases were raised from the egg. We find many

* Entomological Contributions, No. II. By J. A. Lintner. From the twenty-fourth Annual Report on the New York State Museum of Natural History, for the year 1870. 8vo. pp. 66.

remarks on the habits of these insects, their mode of constructing their cocoons and the food plants of the caterpillars. The author describes quite fully two sexes of the larva of *Thyreus Abbotii*, which is "peculiarly interesting from the fact that its two styles of ornamentation, in marked contrast one with the other, indicate the sex of the insect, no other instance of which among the Lepidoptera is known to us. The dorsal and lateral series of spots, yellow as described above, but frequently and perhaps usually of a pale green color, denote the male; the female being brown, without any trace of the above spots, but with interrupted, dark, subdorsal and stigmatal bands and numerous small longitudinal patches." The remarks on the varieties of *Smerinthus geminatus* Say will attract the attention of entomologists, since the author found among some moths of this species, "a female, having but a single blue pupil on the black ocellated spot of the secondaries. The occurrence of this variety is peculiarly interesting from the fact that upon specimens differing from the type of *S. geminatus* mainly in having but a single pupil, two other species seemed to be based, viz., *Sphinx ocellatus Jamaicensis* of Drury and *Smerinthus Cerisyi* of Kirby. . . . A careful comparison of Drury's figure with our variety leaves scarcely a doubt of their identity." Other specimens show "quite an approach" to *S. Cerisyi*, which Mr. Lintner thinks "is, in all probability, a simple variety of *S. geminatus*." We are glad to see that the specific name Io is restored to what Walker called *Hyperchiria varia*. The reviewer acknowledges the correctness of Dr. Speyer's decision. The author advocates the rearing of caterpillars upon growing plants, which is becoming a favorite method with lepidopterists. In conclusion, we must confess ourselves greatly pleased with this brochure as it considerably advances our knowledge of the lives of our butterflies and moths.

As we are going to press with this notice, the first series of "Entomological Contributions" comes to hand. It is replete with new and interesting details concerning the life of our butterflies and moths. The history of *Hemileuca Maia* occupies twenty pages. We have also elaborate descriptions of the early stages of *Melitæa Phaeton*, *M. Nyceteis*, and *Pieris oleracea* and descriptions of three new species of Nisoniades, and a new Ellema. The other notes of times of capture, etc., are of practical importance.

Collectors will find some useful hints regarding field work. We quote the following passage: —

"Mr. Meske's field collections are made with unusual care. A gauze net is used by him, of so delicate a texture that the captured insect, in its efforts to escape, may brush against its sides without the loss of any of its cilia. As quickly as possible it is withdrawn from the net in a wide-mouthed bottle, and speedily quieted by a few drops of chloroform, poured on some cotton contained in a glass tube passing through the cork. When the insect is dead, or nearly so, it is carefully turned out on the palm of the left hand, and in that position pinned, without taking it as is usually done between the fingers.

I have found a lump of cyanide of potassa, secured by a piece of gauze to the stopple of a bottle (a French mustard jar with its hollow screw stopple forms an excellent collecting bottle), to be more convenient for use than chloroform, and nearly as prompt in its effects."

We are quite well satisfied with the use of cyanide of potassa.

A Hand-book of British Fungi.*—The increasing interest in the study of the Fungi, especially their microscopic forms, leads to the frequent inquiry for some compact and trustworthy manual of this somewhat puzzling class of plants. Mr. Cooke is well known as an enthusiastic and experienced author on the subject, and this treatise is the best which the English or American student can employ to assist him in his home researches. References to United States habitats are largely given, and the measurements and descriptions by Greville, Fries, Berkeley, Smith, etc., added to Mr. Cooke's own observations on almost every species. In classification, the author has endeavored to simplify the arrangement, as much as the great influx of new discoveries would permit. To have succeeded, however imperfectly in this, is to have earned the gratitude of every student of the Fungi—for no branch of botany has been in greater confusion and embarrassment of nomenclature. The extremely plastic character of fungus life is perhaps an excuse for this, but Mr. Cooke seems to have taken hold of the difficulty with courage and to have worked with decided views of his own, which it is to be regretted that the proposed limits of the volumes left him no room to explain at length. The references are very full, much more so than the size of the work would prom-

* Hand-book of British Fungi, with full Description of all the Species, and Illustrations of the Genera. By M. C. Cooke, M.A., London and New York: Macmillan and Co. 8vo, 2 vols., pp. 982. Price $12.

ise. The spore measurements, a delicate but necessary matter, have been well done. It may be added, that since the appearance of this work Mr. Cooke, in company with Mr. C. H. Peck of Albany, New York, has been engaged in the study of the Erysiphei of the United States, and has already published several papers which might well accompany the hand-book to the study table of any American botanist.—E. C. B.

BOTANY.

Second Growths in Trees.—A matter which has not received the attention which perhaps it deserves is the growth of trees twice or more during the same season. Some, like the horse chestnut, make but a single growth, when the upper leaves are reduced to perfect bud scales; and although there is, probably, a growth of the embryonic parts of the next year's leaves and flowers beneath these scales for sometime afterwards, to all appearance growth ceases for the season. Others, as in the Norway and sycamore maples, gradually decrease in the size of their leaves as midsummer approaches; the internodes occupy less and less space, but before finally taking on the condition of a terminal bud a new growth commences, the leaves grow larger, and before the final fall resting comes, they have nearly reached the size of those of the early summer time. The English oak almost always makes two of these growths, and sometimes three, and this is also the case with *Pinus mitis*, *P. Banksiana*, *P. inops*, *P. pungens*, and sometimes but not so frequently in *P. rigida* and *P. Tæda*. I think it likely that in most trees which make a continuous growth through the summer season there is more or less of this growth rest, and successive reaction. In the apple tree, and the Carolina and cottonwood poplars, this approach to rest about midsummer is very plainly seen by a shortening of the internodes; after this they again widen, and in the case of these two, the leaves of the second growth are much larger and more vigorous in every respect than those of the first cycle or wave of growth. I have often set myself to the study of the causes of this varying growth force, without feeling satisfied that I could comprehend them clearly. In some way it would seem to be dependent on the powers of nutrition, as in the apple and many other trees it is only the most vigorous shoots which make a re-

newed start; but on the other hand I have seen two trees of English oak side by side together for about twenty years, one making mostly three of these growth cycles, and the other but two, and yet up to this time neither of these has gained any advantage in size over the other. Again, in the case of the horse chestnut, if the leaves be picked off before the terminal bud is quite mature, it will make another growth the same season. In like manner if the leaves of most trees be taken off before the cycle of growth has been quite completed, most of the axillary buds, which otherwise would have remained dormant till the next year, will at once push into growth. If the leaves have to aid in the *immediate* nutrition of the axis with which they are connected, which I am sometimes led half to doubt, the check to nutrition by their loss seems rather to aid more than full nutrition does in the secondary axial development. It is however certain that it is the most vigorous growths on any tree, or the most vigorous individuals, or even varieties, which make these repeated cycles. The common European ash rarely makes a second growth unless in a very vigorous condition. The variety *heterophylla*, which makes a longer, and a stouter growth, usually makes two; but another variety, known in gardens as *Fraxinus excelsior jaspidea*, which has stouter branchlets than either, generally makes three growths.

It would be very interesting to know exactly the relation between nutrition and accelerated growth as exhibited in these successional waves. I have, in papers no doubt familiar to many of your readers, shown how varying powers of nutrition modify the form of leaves, and in other cases even regulate the production of the sexes; and it is by no means improbable that the same laws will be found operative in the production of species itself; for frequently specific, perhaps one might say generic, differences are no greater, than are sometimes found in the varying growths on the same tree, or the differences between one sex and another. This is a well known fact, as genera of both plants and animals have not unfrequently been founded on specimens which were in time found to be but another sex of the same thing.

A knowledge of these successive annual growths may aid our friends in systematic botany. As Mr. Gilman points out, in the AMERICAN NATURALIST Vol. vi, p. 684, in his note on the gray pine, Dr. Engelman divides our American pines according as the female flower is lateral or terminal. But really all these pines are

terminal,—that is to say the flowers terminate one or the other of these growth cycles. If the shoot makes but one of these efforts, the flower remains terminal; but if after forming these buds, it "concludes" to go on again with another growth, the flower is of necessity pushed aside, and then the cone becomes lateral. In other words, there is no such thing in Pinus as a lateral cone when there is but a single cycle of annual growth, and therefore the division of Dr. Engelman is founded on an accidental rather than an organic difference. I think however that what are known as the terminal flowered group never make a second growth, and therefore Dr. Engelman's division is excellent, only changing the description into "Pines which never make a second growth" and "Pines which generally do." The gray pine can then stay where it is without the creation of an intermediate group as suggested by Mr. Gilman.

In the suggestions I have made here, there is nothing new. They have appeared at various times during the past six years in the "Proceedings of the Academy of Natural Sciences of Philadelphia;" but I suppose the mission of the NATURALIST is to extend knowledge, as well as to record the discovery of new facts.—THOMAS MEEHAN.

ZOOLOGY.

THE SLAUGHTER OF THE BUFFALO.—The destruction of this noble beast was carried on during the past year with a rapidity entirely unprecedented, although it has been a matter of regretful comment for years. I have authority for the assertion that one firm in Leavenworth received thirty thousand hides per month, while two others in Kansas City received fifteen thousand each in the same time. This is at the rate of two thousand slain per day. The immense piles or stacks of hides, to be seen at all the stations along the line of the Kansas Pacific railroad, bear witness to the slaughter. Prof. Mudge of Manhattan, Kansas, who is well informed as to the economy of the plains, places the number killed at one thousand, a number sufficiently high to insure the early extinction of the species.

It is to be greatly hoped that Congress will early take action for the preservation of a reduced herd of buffalo, in a reservation set apart for the purpose, or enact protective laws. Such might impose penalties on persons found in possession of any part of

the animal during certain months, a sufficient time being allowed for their increase. At present, this finest of our wild animals ranges over territory which will long remain unsettled, owing to its want of water. While the river bottoms of Kansas, Nebraska, Colorado, etc., will soon be taken up, the high plains of those regions will be utterly void, unless occupied by nature's tenants, the buffalo, prong-horn, elk, etc. Artesian wells for irrigating these tracts are still in the far future.

The government of China has preserved several species of animals from extinction in the imperial parks and preserves. The Czar of Russia has protected the European bison from destruction in the old forests of Lithuania. Our own government preserves the beauties of the inanimate creation in the Yellowstone park. How much more should it keep for the instruction of future generations a full representation of those higher works of creative mind, the living beings that characterize our continent.—E. D. C.

A PARTIAL COMPARISON OF THE CONCHOLOGICAL FAUNÆ OF PORTIONS OF THE ATLANTIC AND PACIFIC COASTS OF NORTH AMERICA. —A distinguishing feature in the conchological fauna of that portion of the Pacific coast included between the Straits of Fuca and San Diego, and which is called the Californian and Oregonian Zoological Province, when compared with the Atlantic coast of North America, from the Arctic seas to Georgia, is the preponderance in the former province over the latter of those forms of molluscan life included in the order Scutibranchiata.

The total number of marine molluscan species and well-marked varieties, so far as known and determined, in the Californian and Oregonian Province, is in round numbers 630, of which about 200 are bivalves, and of the remaining 430, 123 are included within certain Scutibranchiate families. Of this 123, no less than 40 belong to the Chitonidæ and as many more to the Trochidæ.

Of the 247 marine gasteropods enumerated by the late Dr. Stimpson in the Smithsonian Institution check-list, from the Arctic seas to Georgia, 32 only, or less than one-eighth, come within the order referred to; of this number, 14 belong to the Trochidæ, 7 to the Chitonidæ, and not a single specimen of Haliotis has been found as yet within the limits named, and only a single individual of very small size has as yet been reported from any point on the Atlantic coasts of the two Americas, and the solitary specimen

referred to was dredged by Count Pourtales in the Florida Gulf Stream a few years ago. When the shells of Florida are sufficiently investigated, so that a check-list may be made, it may somewhat affect this comparison, but other Scutibranchiate species may be found on this coast, so that it is highly probable that the above comparison will remain substantially correct. — R. E. C. Stearns.

Collurio Ludovicianus. — A male in fine plumage, now in my possession, was shot in West Newton, Mass., Oct. 21, 1872, by Mr. Joseph S. Maynard. Allowing the existence of two varieties, if not species, I think this specimen approaches nearer to *Ludovicianus* than *excubitoroides*. Is not this the first recorded instance of the authentic occurrence of this southern and western bird in the coast states, or at least near the coast, north of Virginia if not the Carolinas?—H. A. Purdie, *November*, 1872.

Raccoon Fox. — In the June number of the American Naturalist (page 362), I find a notice that one of these little animals had been killed, and another seen in Fairfax County, Ohio, and it is remarked, in connection with its northern locality, that the specimen obtained was furred instead of haired. The range of the *Bassaris astuta* is much greater than your correspondent supposes, unless there be two varieties or two species of this genus. They are found, I believe, throughout California, as far north as the Klamath River, Lat. 41° N., where, in 1852, I purchased from an Indian a breech clout made of seven skins, the fur of which was very soft and beautiful. I heard at the time that the "Raccoon Fox," as the miners called it, had occasionally been tamed and employed to destroy mice and other vermin. In Cooper and Suckley's Natural History of Washington Territory, etc., p. 114, your correspondent will find a reference on my authority to the above *habitat*. I doubt if it extends into Oregon, as the Siskiyou Mountains, parallel of 42° N., form a geographical boundary for several species of animals, birds and plants.

The specimens in question were probably escapes, brought either from Kansas or California by some returned miner or emigrant. — George Gibbs, *New Haven*.

GEOLOGY.

On a new Sub-class of Fossil Birds (Odontornithes). — The remarkable extinct birds with biconcave vertebræ (*Ichthyornidæ*),

recently described by the writer from the upper Cretaceous shale of Kansas,* prove on further investigation to possess some additional characters, which separate them still more widely from all known recent and fossil forms. The type species of this group, *Ichthyornis dispar* Marsh, has well developed *teeth in both jaws*. These teeth are quite numerous,.and implanted in distinct sockets. They are small, compressed and pointed, and all of those preserved are similar. Those in the lower jaws number about twenty in each ramus, and are all more or less inclined backward. The series extends over the entire upper margin of the dentary bone, the front tooth being very near the extremity. The maxillary teeth appear to have been equally numerous, and essentially the same as those in the mandible.

The skull is of moderate size, and the eyes placed well forward. The lower jaws are long and slender, and the rami are not closely united at the symphysis. They are abruptly truncated just behind the articulation for the quadrate. This extremity, and especially its articulation, is very similar to that in some recent aquatic birds. The jaws were apparently not encased in a horny sheath.

The scapular arch, and the bones of the wings and legs, all conform closely to the true ornithic type. The sternum has a prominent keel, and elongated grooves for the expanded coracoids. The wings are large in proportion to the legs, and the humerus has an extended radial crest. The metacarpals are united, as in ordinary birds. The bones of the posterior extremities resemble those in swimming birds. The vertebræ are all biconcave, the concavities at each end of the centra being distinct, and nearly alike. Whether the tail was elongated cannot at present be determined, but the last vertebra of the sacrum is unusually large.

This bird was fully adult, and about as large as a pigeon. With the exception of the skull, the bones do not appear to have been pneumatic, although most of them are hollow. The species was carnivorous and probably aquatic.

When the remains of this species were first described, the portions of lower jaws found with them were regarded by the writer as Reptilian; the possibility of their forming part of the same skeleton, although considered at the time, was not deemed sufficiently strong to be placed on record. On subsequently removing the surrounding shale, the skull and additional portions of both

* American Journal Science Arts, vol. iv, p. 344, Oct. 1872, and vol. v, p. 74, Jan., 1873.

jaws were brought to light, so that there cannot now be a reasonable doubt that all are parts of the same bird. The possession of teeth and biconcave vertebræ, although the rest of the skeleton is entirely avian in type, obviously implies that these remains cannot be placed in the present groups of birds, and hence a new subclass, *Odontornithes*, is proposed for them. The order may be called *Ichthyornithes*.

The species lately described by the writer as *Ichthyornis celer*, also had biconcave vertebræ, and probably teeth. It proves to be generically distinct from the type species of this group, and hence may be named *Apatornis celer* Marsh. It was about the same size as *Ichthyornis dispar*, but of more slender proportions. The geological horizon of both species is essentially the same. The only remains of them at present known are in the museum of Yale College.

The fortunate discovery of these interesting fossils is an important gain to palæontology, and does much to break down the old distinctions between birds and reptiles, which the Archæopteryx has so materially diminished. It is quite probable that that bird, likewise, had teeth and biconcave vertebræ, with its free metacarpals and elongated tail. — O. C. Marsh, *reprinted from advance sheets of the American Journal of Science and Arts for February*, 1873.

ANTHROPOLOGY.

Change in the Form of Skulls with age.—The hypothesis, at one time so universally held, says Virchow, that all longheaded skulls were Celtic, may now be taken as an example of how easy it is to overstep the mark, and of the caution that should be exercised in anthropological inquiries. Any conclusions that may be drawn from the forms of skulls of early times are quite open to question. The influence of culture has hitherto been too little considered. Schaffhausen has observed that the growth of the skull continues to a later period than was formerly supposed, and that it increases in breadth in old age. This explains how it happens that so many more of the long and narrow skulls have been traced to earlier times, and that the proportion of the broader ones increases in the quaternary epoch. In the case of the broad skulls the brain has usually attained fuller development, while the most remarkable long and narrow skulls are to be met with among

lower races. For this reason, then, peculiarities of races become obliterated in time. — *The Academy.*

MICROSCOPY.

A Field-stage for Clinical Microscopes.— Dr. R. H. Ward called attention at the Dubuque meeting of the American Association, to a contrivance by which he is able to employ in field work the ordinary form of clinical microscopes. Such microscopes are but little available for opaque objects, the small opening sometimes made through the tube just above the stage being objectionable in respect to focussing and being nearly useless for illuminating purposes by ordinary daylight. The new field-stage is a perforated brass stage-plate occupying the position of the object and bearing a contrivance by which the object is carried at the distance of about an inch lower down. In the instrument shown to the Association, which was home-made and could be made by any one in a few moments, a heavy brass wire was carried down from the brass stage-plate, bent so as to form a rectangular frame on which the object-slide or compressor could rest, and then bent back to the stage-plate again. It was attached to the stage-plate by being bent at right angles and soldered along the sides of the plate to its under surface. The object was held upon this accessory stage by slender wire springs also soldered fast. With this new stage the clinical microscope becomes available for low powers and opaque objects.

Pigott's "Searcher" in the Binocular.— Dr. John Barker exhibited to the Dublin microscopical club a one-inch objective employed as a "searcher," as suggested by Dr. Pigott. His object was to propose its application to the binocular microscope by inserting a one-inch objective in each body, and thus attain in connection with stereoscopic vision, the high amplifying power of such arrangements.

Under-corrected Objectives.— Objectives considerably undercorrected as to color are now furnished by a variety of leading makers and are generally preferred by critical microscopists. They not only work better for photography and with monochromatic illumination, but they excel for ordinary work those lenses in which the corrections for spherical aberration are sacrificed for the sake of a more perfect achromatism. Powell and Lealand, Tolles

and Gundlach are prominent examples of those makers who seem to have adopted this policy of under-correction for color.

MICROSCOPY IN NEW JERSEY.— Mr. E. Gundlach, the celebrated proprietor of the Optical Institute at Charlottenburg, Prussia, has removed his residence to this country. He is now living at Hackensack, New Jersey, where he proposes to devote his attention exclusively to the manufacture of first-class objectives.

DETERMINATION OF POWERS IN THE COMPOUND MICROSCOPE.— This subject was discussed at a meeting of the Queckett club, and a variety of appliances recommended for the purpose. The simplest plan, and one familiarly employed by many microscopists, was advised by Mr. S. J. McIntyre who ascertained the apparent size of the field of view, and reduced it to thousandths of an inch, and divided that number by the number of divisions of a stage micrometer (ruled to thousandths of an inch), included in the field of view. Thus if the apparent field of view with a certain ocular is five inches ($\frac{5000}{1000}$) and with a certain objective it includes twenty-five divisions of a stage micrometer ruled to thousandths, then the power of the microscope as thus arranged will be $\frac{5000}{25}=200$. With another objective it may include four divisions, and the power will be $\frac{5000}{4}=1250$. This plan is sufficiently accurate for practical purposes, and is, on the whole, the easiest method in use.

SECTIONS OF INSECTS.—Mr. Henry N. Moseley advises to harden the insects by immersion for about a week in absolute alcohol. They are then, or any time afterward, to be embedded in a mixture of sweet oil and wax of suitable hardness, which he prefers to paraffin, and sections are to be cut with a sharp, thin edged razor wetted with absolute alcohol. The sections are to be immediately floated off on to slides, stained with carmine, treated with absolute alcohol and then with oil of cloves, and mounted in Canada balsam or dammar varnish in the usual manner. Extremely beautiful specimens are thus prepared, showing the general anatomy of the insect. Instructive objects are obtained by sections passing through the eyes, especially if carried at the same time through the cephalic ganglia. The eyes of the mollusca, leeches, etc., may be similarly prepared.

STAINING TISSUES.—Dr. R. L. Maddox has been studying the

tissues of the frog's tadpole's tail, with special reference to the distribution of the nerves, and relates his method of preparing the tissues in the "Monthly Microscopical Journal." Beautiful results were obtained by placing the tadpoles for about five minutes in a mixture of three drams of chromic acid solution (one-fourth per cent.) and twenty drops of sweet spirits of nitre; then washing repeatedly in pure water, immersing for about three minutes in ammoniated water (four drops strong liquor ammonica to three drams of water), washing off the epithelium in pure water with a camel's hair pencil and rewashing repeatedly in pure water; then staining for about five minutes in tincture of logwood diluted with pure water to a sherry color, or in a purple aniline solution, and finally mounted in a nearly saturated solution of acetate of potash slightly acidulated with acetic acid. After staining with logwood an improved result was obtained by washing in the usual iron developer with acetic acid employed for developing photographic negatives. Glycerine was tried as the mounting medium, but seemed inferior to the acetate of potash.

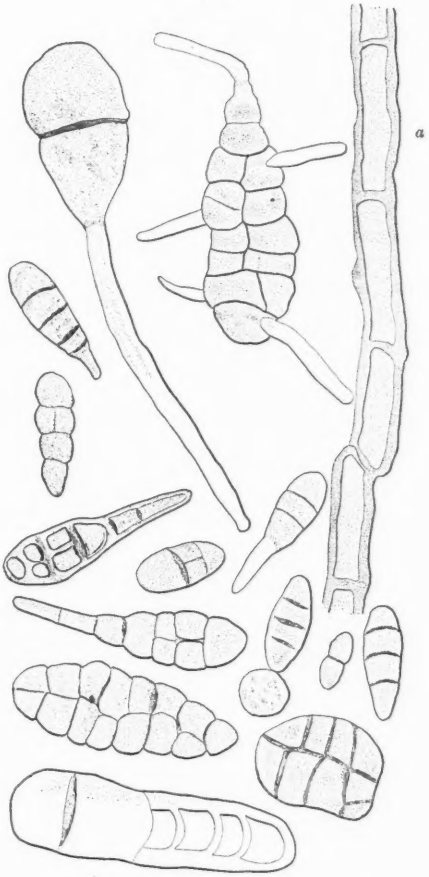
Preparing Palates of Mollusks.—The plan of preparing these palates by boiling in *liquor potassæ*, instead of by dissection, proposed by Mr. Hennah and published eight years ago in the "Intellectual Observer" has recently been inadvertently claimed as a novel American idea.

Mounting Entomostraca.—Mr. O. S. Westcott, after experimenting with various substances, has concluded that a carbolic acid solution, exceedingly dilute is the best mounting medium for the preservation of these minute animals.

The Horse Disease.—I have recently made a series of microscopical examinations of the matter from the nostril of a horse suffering with the epizootic influenza now so generally prevailing. A power of seven hundred, with Beck's $\frac{1}{5}$ inch objective, was used in making the observations, and in preparing the accompanying drawings. The great mass of the discharge consisted of mucous and pus corpuscles, with many epithelial cells: but I find therein the spores of three species of cryptogamous plants. The spores are all of a brown color, and occur to the extent of thousands in a single drop. One kind, figure 26, are supposed to be spores of *Urceolaria scruposa* a species of lichen: these were in every stage of development, there being hundreds of the fragments of the stem

(Fig. 26, *a*), in a drop. The second kind (Fig. 27) were echinulate spores, probably of some species of *Aspergillus;* and they, as well as the others, gave evidence of propagation and growth.

Fig. 26.

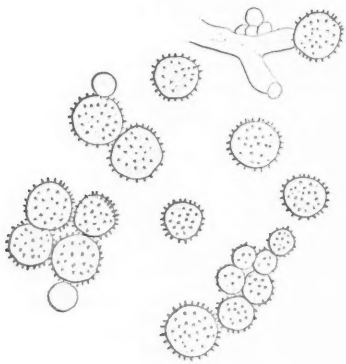


×700.

The third kind (Fig. 29) were smooth, globular spores, species unknown. A few confervoid filaments (Fig. 28) were present; and also some other organized forms, but not in sufficient numbe$_r$

to be worthy of remark. Sometimes one of the spores divides into several cells and sends forth a shoot from each division, a

Fig. 27.



× 700.

number of sprouts being seen growing from one spore in different directions, giving visible evidence of vegetal growth taking place.

Fig. 28.

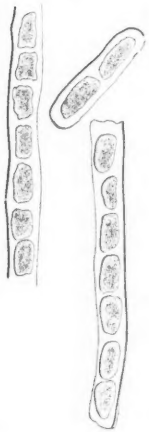
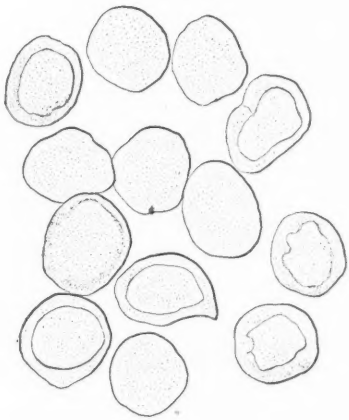


Fig. 29.



× 700.

To ascertain if these organisms were also present in the air, I exposed some clear glass slides to the external air for a few days,

and on examination with the microscope had the satisfaction of finding many of them. It seems to be proved then that the spores are floating freely in the atmosphere, and are inhaled into the air passages. The heat of the animal and the moisture of the mucous surfaces favor their germination and growth; and it seems to me possible that the epidemic catarrhal horse disease, and similar difficulties of man, may be caused by these vegetating spores, the greater or less prevalence of this class of diseases being governed by the relative numbers of the germs in air at different seasons, some seasons being more favorable to their development than others.—G. W. Morehouse, *Wayland, New York.*

Organisms in Chicago Drinking Water.—Mr. H. H. Babcock discusses this subject in a paper read at the Dubuque meeting of the American Association. His former suspicions are confirmed, that these forms are not at home in the southern end of the Lake, but are brought down from the north by a surface current along the western side of the Lake. The existence of such a current he finds further proved by the vegetation upon the shores, as he observed at least eleven species of plants established in isolated and evidently accidental positions on the shores near or below Chicago, but which belong at the northern end of the Lake or in the region of the sources of its water.

Pine Pollen in Lake Michigan.—At the Dubuque meeting of the American Association, Dr. R. H. Ward made a report on a specimen of viscid-looking water from Lake Michigan, near Racine. The water of the lake was similarly thickened for miles and was generally believed by the neighboring residents to be of an infusorial character. It contained no infusoria worth speaking of; but was almost filled with pine pollen which was interesting from its enormous quantity, and from the fact that its source could not have been near by, but must have been in the pine forests far to the north, the pollen being brought down by the southerly current along the western shore of the Lake.

NOTES.

At a meeting of the California Academy of Sciences held October 7, 1872, Mr. W. H. Dall presented a portion of the husk and inner shell of a cocoanut picked up on the north side of the Island

of Oonalashka, especially interesting as showing the direction of the ocean currents in that region.

Capt. C. M. Scammon, U. S. R. M., submitted a description of a new species of whale, *Balænoptera Davidsoni*, the geographical range of which is from Mexico to Behring Straits; the specimen from which the description was made was taken in Admiralty Inlet, Washington Territory. It was a female twenty-seven feet in length and contained a fœtus five feet long, thus correcting a prevalent error among the whalers who have generally regarded this small species as the young of the "finback" of the coast; this animal and its habits will be fully described in the volume now being printed on the "Cetaceans and other Marine Mammals" by Capt. Scammon.

Prof. George Davidson read a paper entitled "Suggestion of a Cosmical Cause for the great Climatic Changes upon the Earth."

"Disliking theories and hypotheses, I must characterize as a suggestion what I have to state upon this subject.

So far as I am aware, geologists have failed to indicate any reasonable or rational existence of a cause for the subtropical fossil flora and fauna found within the Arctic Circle, and for the great ice-sheet—the universal glacier—which doubtless covered nearly the whole land from the poles toward the tropics at a comparatively recent period. To mention is to condemn the extravagant hypothesis of the changing of the direction of the earth's axis, as it involves changes in the gyration of the earth necessarily of greater relative amount than the motions of a boy's top. Partial upheavals and great changes of the surface of the earth are insufficient to account for the phenomena.

The palæontologist has roughly indicated by his zones of fossil floras and fossil faunas that the pole of the earth has not changed its direction, and the astronomer utterly rejects such a change.

My suggestion is that we must look to a cosmical cause for these phenomena; and that cause is in the material or materials burning upon the surface of the sun.

The spectroscope has made known to us the connection between sudden outbursts or storms upon the sun's surface, and the exhibition of magnetic or electrical phenomena on the sun. There has been established a correspondence between the eleven year period of the solar spots and certain other magnetic phenomena. This instrument has revealed to us a sun wherein a sudden outburst of

luminous hydrogen has increased the brilliancy of a star from the ninth to the second magnitude, and its comparatively slow return to its former condition.

It appears to me that herein we strike the key-note of the causes at work to solve our problem of short or long periods of varying climate upon the earth. If the above phenomenon is possible in one sun, it is possible in every one of the millions of millions of suns around us; and of course in ours. That such an eruption of burning hydrogen affects the planets revolving around that sun, we can not for one instant doubt. To our instruments it was an exhibition of force lasting but a few months, and its effect upon probable planets around that sun we can never know. Doubtless all new stars that have suddenly appeared with great brilliancy were the exhibitions of similar forces. If such forces are possible for short periods, they are possible, and to my mind more probable, for comparatively long periods. In our sun the forces are apparently evolved in irregular, and also in moderately regular periods or cycles, and must have an influence upon the general climate of the earth and of the other planets. Even in this year of exceptional heat over the earth, we have the results of the spectroscope, revealing an unusual development of incandescent magnesium over the sun's surface.

If these forces of the sun exhibit themselves in short and long periods, we can comprehend how periods of almost universal flood, of earthquake and volcanic action, of a climate to develop a subtropical fauna and flora, even within the Arctic Circle; of a great ice-sheet spreading from each pole, over the land, toward and even embracing the Equator, may be not only probable, but place the latter two in full accord with the astronomical dictum, that no violent change of the direction of the earth's axis is admissible.

The spectroscope is the present means of gathering observations to test my suggestion, or to develop the law underlying these changes; and as we observe the exhibitions of the forces upon the surface of our sun, and note the effect upon the earth, we can also watch the changes upon Mars and the other near planets. But we cannot hope to determine the law of connection within a short time, unless some wonderful event happened in our sun similar to the sudden outburst of luminous hydrogen in the star in the Northern Crown, to show us in an hour the effect such great cosmical changes have upon the earth and other planets of our

system; or unless other instrumental means far beyond the capacity of the spectroscope be devised to show minute connections between changes on the sun's surface and limited periods of phenomena on the earth, such as years of great heat, and earthquake and volcanic activity, perhaps even years of pestilence. A long cycle of years may be required to demonstrate whether a law lies at the base of my suggestion.

Like the observers who make their measures to determine the gradual elevation or subsidence of continental shores, we may not learn the result, but we can aggregate observations for discussion by the next generation."

Mr. W. H. Dall submitted descriptions of new species of shells from the northwest coast of America with notes on species previously described; this paper includes a description of a new species of Voluta of the group Scaphella, particularly interesting as being the first of this family from so high a northern station (Shumagin Island) though allied forms have long since been reported from the Straits of Magellan. To this species, which is of large size, being over four inches in length, Mr. Dall has given the name of *Voluta Stearnsii*. *Buccinum Kennicottii* Dall, described in one of the latter numbers of the "American Journal of Conchology," proves to be a Chrysodomus. A new species of Littorina is also described in this paper as *L. Aleutica* Dall.

Professor Davidson called the attention of the Academy to the earthquake waves recorded by the tidal gauges on this coast on the 23d to 27th of August and on the 16th to 17th of September last. He demonstrated by deductions from the relative rapidity and heights of the waves at different points, that the main shock of the first must have been near the northern coast of the island of Yesso, Japan, and that the latter had originated not far distant in the ocean from the points of observation.

Mr. Stearns read a paper pointing out the predominance, in the Californian and Vancouver zoological provinces, of mollusks included in the Order Scutibranchiata (*Vide* Adams' Genera) as compared with the Atlantic coast of America from the Arctic seas to Georgia.

H.M.S. "Challenger" corvette, of 2306 tons, Commander G. S. Nares, has been despatched by the Admiralty on a circumnavigation of the globe, for the purpose of dredging, sounding, and

otherwise scientifically investigating the deep sea. The scientific staff consists of Prof. Wyville Thompson, Director; Mr. J. J. Wild, of Zurich, artist and private secretary; Mr. J. Y. Buchanan, chemist; Mr. H. N. Mosely, Mr. John Murray, and Dr. von Willemoes Suhm, of Munich, naturalists. The expedition is expected to return in April 1876. They will visit Madeira, Canaries, Porto Rico, New York, Azores, Cape de Verde, Fernando de Noronha, Bahia, Cape of Good Hope, Prince Edward's Isle, Crozets, Kerguelen's Land, Melbourne, and possibly sail round New Zealand, thence round North Australia, follow Wallace's line up to the Philippines, touch New Guinea, Japan, Kamtschatka, Behring's Straits, Vancouver's Island to Varparaiso; thence through the Straits of Magellan to Rio, and so home. Though no botanist is attached to the staff, it is understood that Mr. Mosely will collect plants on every possible occasion.

The immediate value of geological surveys is again shown in the prompt detection of the recent diamond fraud. Mr. Clarence King, the U. S. Geologist, and his assistant Mr. J. T. Gardiner, visited Bishop Mountain and finding diamonds and rubies there that had been scattered over the soil by another hand than Nature's, exposed a gigantic and disgraceful swindle. The New York "Nation" makes some timely remarks on the value of the unbiassed opinions and observations of a national geologist. Certainly by the exposure of this fraud, the government survey of the public lands has more than paid for all the funds appropriated by Congress, and justifies the conclusion that the largest liberality in scientific enterprises is the truest economy—in short, science pays.

Prof. F. V. Hayden is desirous of securing by exchange or purchase, the publications of our own as well as foreign countries on Geology, Palæontology, and Natural History generally, to aid in the formation of a library of reference, for the use of the survey of which he has charge. The reports of surveys, with maps, charts, and sections, transactions of societies, or the publications of individuals engaged in scientific studies, are much desired as works of reference. Parties who may look favorably upon the above proposition can send all packages, through the Smithsonian Institution, to the address of Dr. F. V. Hayden, U. S. Geologist, Washington, D. C.

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